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JANUARY 1976

REPORT

OAD-CR-142

Method for Integrated Simulation (MINTSIM)

by

Norman Farrell
Philip H. Lowry
John E. Shepherd

Prepared for
The Department of the Army
Contract No. DAAG-39-75-C-0127

OPERATIONS ANALYSIS DIVISION
GENERAL RESEARCH CORPORATION
WESTGATE RESEARCH PARK, McLEAN, VIRGINIA 22101

1473

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 14 OAD-CR-142 ✓
2. GOVT ACCESSION NO.:
3. RECIPIENT'S CATALOG NUMBER: 9
4. TITLE (and Subtitle): 6 METHOD FOR INTEGRATED SIMULATION (MINTSIM)
5. TYPE OF REPORT & PERIOD COVERED: Final rept.,
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): 10 Norman Farrell, Philip H. Lowry, John E. Shepherd
8. CONTRACT OR GRANT NUMBER(s): 15 DAAG39-75-C-0127
9. PERFORMING ORGANIZATION NAME AND ADDRESS: GENERAL RESEARCH CORPORATION, Operations Analysis Division, McLean, Virginia 22101
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: ~~67701~~ 12 191 p.
11. CONTROLLING OFFICE NAME AND ADDRESS: HQ, Department of the Army, ODCSOPS, War Plans Division (DAMO-SSW), Washington, D. C. 20310
12. REPORT DATE: 11 January 1976
13. NUMBER OF PAGES: 195
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report): UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:
16. DISTRIBUTION STATEMENT (of this Report): Distribution to other agencies, T&E must be approved by Chief, War Plans Division, ODCSOPS, HQ, Department of the Army, Washington, D. C. 20310

3 FEB 1976

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report):
18. SUPPLEMENTARY NOTES:
19. KEY WORDS (Continue on reverse side if necessary and identify by block number):

Battlefield nuclear weapons	Methodology	Target acquisition
Conventional-nuclear interactions	NATO	
Command-control-communications	Nuclear attack	
Collateral damage	Nuclear-conventional interactions	
Escalation control	Political constraints	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

This report provides the specifications for a fast and comprehensive simulation of tactical nuclear war and conventional operations under the threat of nuclear war. The model focus is on military decision-making under specified political constraints on the employment of nuclear weapons in a theater. Means are provided for evaluating the military effect of political constraints, command-control-communications, target acquisition, intelligence, combined nuclear-conventional (cont on p 1473B)

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390 551

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20. Abstract (cont'd)

fr P1473A

operations, conventional attack of nuclear targets, and air-ground interactions.

1473B

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SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Tactical Warfare Operations | Contract Report OAD-CR-142 | Published January 1976

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(MINTSIM)

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DISTRIBUTION STATEMENT T4E 3 FEB 1976
Distribution to other agencies must be approved by Chief, War Plans Division, ODCSOPS, HQ, Department of the Army, Washington, D.C. 20310

GENERAL RESEARCH CORPORATION
OPERATIONS ANALYSIS DIVISION
WESTGATE RESEARCH PARK, McLEAN, VIRGINIA 22101

NOTE TO THE READER

The reader should recognize that the rules and policies for the conceptual model discussed in this report are not necessarily complete nor representative of US Army doctrine.

Published
January 1976
by

General Research Corporation
McLean, Virginia 22101

FOREWORD

This report completes the work conducted by the Operations Analysis Division, General Research Corporation, for the Department of the Army on the MINTSIM Study, Method for Integrated Simulation. It provides the specifications for a model to represent combined conventional-nuclear operations in the NATO theater.

The report should be considered as a contribution to the current search for more flexible options and for a better understanding of the interaction of nuclear and conventional forces.

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Director
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ACKNOWLEDGMENTS

The authors are indebted to Mr. Dick M. Lester, Office of the Deputy Under Secretary of the Army (Operations Research), and to COL James F. Miley, Chief, War Plans Division, ODCSOPS, whose support, guidance, and encouragement are responsible for whatever contribution has been made in this study. MAJ A. L. Koestring, ODCSOPS, was of great assistance in securing needed data and minimizing the administrative burden on the GRC study group. COL J. B. Murphy and members of the War Gaming Directorate of the US Army Concepts Analysis Agency provided essential data and helpful criticism.

Dr. Joseph A. Bruner, a member of the study group during the first half and formative period of the study, was responsible for many of the innovations that appear in this report.

Needless to say, none of these individuals bear any responsibility for the form and content of the report.

CONTENTS

EXECUTIVE SUMMARY

OBJECTIVE

Develop the specifications for a fast and comprehensive simulation of tactical nuclear war and conventional operations under the threat of nuclear war.

- **Fast** - time required by the user to prepare inputs for an operating run of the simulation rather than the computer running time.
- **Comprehensive** - scope rather than detail. The specifications simulate theater-wide combat, including nuclear and conventional operations by air and ground forces.
- **Simulation** - a completely automatic model that can produce a theater campaign from beginning to end without human intervention. The program could, if desired, provide an interrupt option when specified events occur.
- **Tactical Nuclear War** - excludes the SIOP and SIOP-related theater strikes.
- **Conventional Operations under Threat of Nuclear War**
  - conventional combat between nuclear powers as in a NATO/Warsaw Pact campaign.
  - conventional operations during nuclear war in areas where neither side uses nuclear weapons.
  - conventional operations following the use of nuclear operations.

MAJOR FEATURES

The specifications allow the user to study a number of issues that concern limited employment of nuclear weapons:

- The military impact of political guidelines for the use of nuclear weapons;
- The contribution of conventional forces and weapons in nuclear war;
- The military impact of present but withheld nuclear weapons on the conduct of conventional war.

The specifications provide features not hitherto incorporated in theater combat situations:

- Breakthrough and envelopment;
- Tactical effect of command-control-communications;
- Evaluation of large numbers of alternative courses of action (nuclear, conventional, and mixed);
- False targets.

Political Guidelines

The specifications incorporate political guidelines that constrain or specify how nuclear weapons can be used. Some of the constraints are:

- Target specifications or exclusions
- Weapons by type or yield
- Delivery systems
- Specified or excluded areas
- Nationality of area, target, or delivery system.

The guidelines are included in the simulation of a commander's estimate of the situation and his selection of the course of action that best meets multiple military and political objectives.

Contribution of Conventional Forces in Nuclear War

Rear Area Targets. There is an explicit method for selecting rear area targets for conventional attack in a nuclear war, when (at the user's option):

- Political guidelines prevent nuclear attack of the target;
- More targets than weapons (delivery systems) are available;
- Conventional attack produces required damage.

Where Nuclear Weapons are not Used. The estimate of the situation requires the simulated commander to specify missions, allocate resources, and provide guidance to subordinate commanders who are not authorized to employ nuclear weapons. The guidance contains specific instructions on dispersal and other measures to reduce vulnerability to enemy nuclear attack at some penalty in conventional capability.

Follow-on Conventional Engagement. The specifications for battle assessment incorporate neutralization, delay, and disorganization produced by nuclear strikes when exploited by follow-on conventional attack or counterattack. The potential of nuclear strikes to unbalance combined arms is included, for example, the increase in friendly antitank missile effectiveness if the nuclear strike seriously degrades enemy artillery.

Impact of Present but Withheld Nuclear Weapons in Conventional War

Soviet official military literature recognizes the increased vulnerability from nuclear attack when forces are massed for quick conventional success. By implication, it also recognizes the increased risk of conventional failure when forces are dispersed to increase nuclear survivability.

The specifications provide a method to evaluate the risk of nuclear attack. When the risk is high enough, the following measures may be ordered:

- Limit the massing of all but specified ground forces.
- Move aircraft to dispersed operating bases and strips.
- Increase allocation of intelligence and target acquisition resources to enemy nuclear systems.
- Attack enemy nuclear systems conventionally.

Breakthrough and Envelopment

The specifications provide a simplified representation of breakthrough and envelopment. The following events produce a breakthrough:

- An attack penetrates the entire depth of a division's defensive zone in less than one day; and
- Counterattacking forces from the shoulders and flanks cannot pinch off the penetration. (It, then, widens to permit follow-on forces of at least division size to pass through and begin exploitation.)

An envelopment occurs when there are two breakthroughs less than a specified distance apart. The enveloped forces are lost as organized units.

Command-Control-Communications

The command-control-communications capability of military units is degraded when:

- Headquarters are destroyed.
- C^3 personnel are casualties.
- Specified events occur (e.g., first use of nuclear weapons against a unit).

The specifications incorporate C^3 degradation in two ways:

- The commander's estimate of the situation is based on less accurate and less timely data.

- Military units have lower performance.

The specifications thus provide an explicit and quantitative way to measure the effect of destroying headquarters and other C^3 centers, which existing simulations do not have.

In addition, units may have different initial C^3 capabilities, depending on the number of alternate headquarters, number of C^3 personnel, and equipment assigned.

Evaluation of Courses of Action

The method for estimating the situation allows thousands of courses of action (including nuclear employment options) to be evaluated in the process of choosing the one that best fits the military situation and satisfies the political guidance.

False Targets

Soviet official literature stresses the need to conceal true units and create false targets by electronic or physical means. The specifications provide three classes of false targets:

- Unrecognized dummies;

- Misidentification of true targets;

- Targets that have moved since last observation.

Unrecognized movement is accounted for by specifying a movement policy (e.g., for headquarters and nuclear missile launchers) and a target retention policy (e.g., the length of time since last observation targets are retained on the attacking commander's list).

GROWTH POTENTIAL AND FLEXIBILITY

The MINTSIM specifications respond to the requirement for a theater-wide combat simulation designed to assist force planners. But the main features of the model could be adapted to meet other requirements and assist other users. For example:

- The model could assist studies of individual weapons systems and force structure by changing the resolution from division to battalion and the scope from theater-wide to a single corps sector.

- The model could assist studies of the air battle and combined nuclear-conventional attacks on rear area targets by treating in more detail the allocation of air and missile resources and reducing the detail in the ground battle.

A number of studies (currently underway or planned) may result in modifications of the input data required in MINTSIM. The specifications, therefore, provide for easy modification of input data, especially in the relatively unstudied areas of combined nuclear-conventional operations and how command-control-communications affect them.

Chapter 1

INTRODUCTION

OBJECTIVE

This report provides the specifications for a simulation of theater war that emphasizes the interaction of conventional and nuclear forces. The model is designed for use where both sides possess theater nuclear capabilities so that all conventional operations are carried out under the threat of nuclear attack and all nuclear operations must include the contribution of conventional forces. The focus is on Central Europe.

BACKGROUND

The US Army General Staff has been concerned about the separation of nuclear and conventional requirements planning and the lack of an accepted methodology for assessing the impact of the nuclear threat on conventional operations between nuclear powers and the contribution of conventional forces and weapons in nuclear combat.

The US Army is revising its operational nuclear doctrine to insure that it is fully responsive to US policy guidance. The policy includes the limited employment of nuclear weapons in one part of a theater while remaining conventional in other parts of the theater. The policy includes the concept that nuclear weapons may be fired only during very short periods, perhaps one or two hours, during and after which the conventional operations take place.

US Army and Soviet nuclear doctrine have always emphasized the use of theater nuclear weapons to help accomplish missions, not merely to produce damage and casualties. Most current nuclear models, however, treat conventional ground forces as a target system, not as a purposeful force.

This report is designed to accommodate the impact of such policies and doctrine.

GUIDELINES

The specifications are for a fast, and comprehensive, simulation of theater-wide operations. Each of these words requires some interpretation.

Specifications

By specifications is meant that the inputs, overall logic, and each model are described in sufficient detail that a fully competent analyst, experienced in theater-wide simulations of warfare, could operate the model by hand.

Fast

"Fast" refers to input preparation time for successive runs of the entire simulation, not the running time of the final computer code. Every effort has been made to simplify and reduce the number and interrelationships of the initial input entries.

It is assumed that the user has available full-strength compositions and conventional effectiveness measures for all military units explicitly simulated in MINTSIM. It is assumed that the user has a nuclear damage assessment model or tables that provide damage and casualties to deployed divisions in various configurations and postures for a particular lay-down of nuclear weapons, given a specified target acquisition capability and casualty criteria.

With these assumptions, it is unnecessary for this report to repeat in detail well-known methods for simulating the noninteractive aspects of conventional and nuclear operations. The emphasis, therefore, is on the interaction of conventional and nuclear forces and weapons and some other unique elements, and how these interactions affect tactical decisions and battle assessment.

Comprehensive

The simulation is to be as comprehensive as possible within the constraint of speedy input preparation. Comprehensive is interpreted as breadth of scope rather than depth of detail. Political constraints on conventional and nuclear deployment and employment are emphasized. Command-control, communications, intelligence, target acquisition, and, to a lesser degree, logistics specifically affect tactical decisions and battle assessment of ground, missile, and air forces on both sides. Although the simulation is one-dimensional, breakthroughs (ruptures) and envelopments can be modeled, although relatively crudely.

Theater-Wide

A theater-wide simulation can only be fast and comprehensive by limiting the number of units explicitly represented on both sides and limiting the number of elements considered in assessing the status of each unit. A ruthless paring of many desirable elements was necessary. The model resolves to NATO division and Pact army, aircraft and air base by type, nuclear launchers and weapons by type. Packages, not individual nuclear weapons, are employed against divisions and armies. Strikes, not individual weapons, are employed against nuclear and other nondivisional targets. Terrain and civilian population are denoted by classes. Weather and darkness are not simulated.

POTENTIAL USES

Military Consequences of Political Control

MINTSIM is a model of military decisions and military operations. It is not a model that simulates the political decisions of heads of state. It follows that one potential use of MINTSIM is to examine the military consequences of political decisions to employ nuclear weapons in limited ways and constrain conventional operations because of the threat of nuclear escalation.

Every selective employment plan or regional nuclear option implies some set of political constraints by both sides. There have been many candidate selective options discussed, studied, and recommended in various studies and documents. But few have been systematically examined in a dynamic model to estimate their impact on the military situation. MINTSIM is designed to provide this capability.

The military consequences of delay and, perhaps even more important, the uncertainty of a political decision to employ nuclear weapons, is a major factor that MINTSIM is designed to investigate. Delay includes the time required to execute a nuclear option after the political decision has been made. Uncertainty includes whether or not the decision to use nuclear weapons will be made and, if it is made, the precise constraints and specifications of the option to be carried out.

Alternative Policies, Doctrine, and Postures

MINTSIM is a two-sided simulation. A potential use is to examine the military impact of major changes in policies and doctrine by either NATO or the Warsaw Pact. MINTSIM also provides a vehicle to find what areas and functions in combined conventional-nuclear conflict require policies and doctrine where none now exist and to help in the evaluation of candidate policies and doctrine in these areas and functions.

MINTSIM is also capable of examining alternative postures for nuclear systems—for example, the replacement of QRA aircraft by missiles, separating theater-based nuclear from conventional forces during a conventional phase of a war, or nuclear withdrawal options.

Scenario Development

Because MINTSIM does not resolve below divisions, it is not suitable for examining the details of nuclear delivery system-warhead-target interactions. It can, however, serve to generate scenarios and a strategic and tactical context for use by more detailed models.

EXCLUSIONS

MINTSIM is restricted to theater war in which conventional ground and air forces have a rational role. The effect of executing the SIOP, NATO's General Strike Plan, and Soviet equivalents is excluded. The effect of large numbers of high-yield weapons is also excluded, as are the war at sea, a war in space, and the deliberate attack of cities.

ORGANIZATION OF THE REPORT

This report contains twelve chapters. The first two chapters describe the background of the study and an overview of the logic of MINTSIM and the major submodels. Chapters 3 and 4 describe the echelons of command that make decisions and the technique used for selecting the preferred course of action by each echelon. Chapter 5 covers the method by which the theater commander on each side orders dispersal and other measures taken in conventional war when a high risk of nuclear war is foreseen. Chapters 6 and 7 describe the technique for determining the impact of command-control-communications, intelligence, and target acquisition on decisions and battle assessment. Chapter 8 describes the air model, including the method for allocating aircraft to missions (air base attack, escort, deep air support and interdiction, and close air support), assessing aircraft attrition, and assessing the impact of close air support on the ground battle. Chapter 9 describes the nuclear model, including political constraints, the decision to employ nuclear weapons, allocation of nuclear weapons, and assessment of nuclear strikes. Chapter 10 describes the method for handling reinforcements, reserves, resupply, replacements, and reconstitution of ineffective units. Chapter 11 describes the ground

combat model, including the representation of theater terrain, units, and assessment, including rupture, envelopment, and counterattack. The final chapter (Chapter 12) provides a summary of the user inputs required to operate MINTSIM and suggested preliminary values or ranges for those inputs unique to MINTSIM.

Chapter 2

OVERVIEW

INTRODUCTION

This chapter provides an overview of the MINTSIM model, its flow and logic. The chapter is also designed to help a reader follow the details presented in subsequent chapters and appreciate how they fit into the overall simulation.

OVERALL STRUCTURE

Figure 1 shows the overall structure.

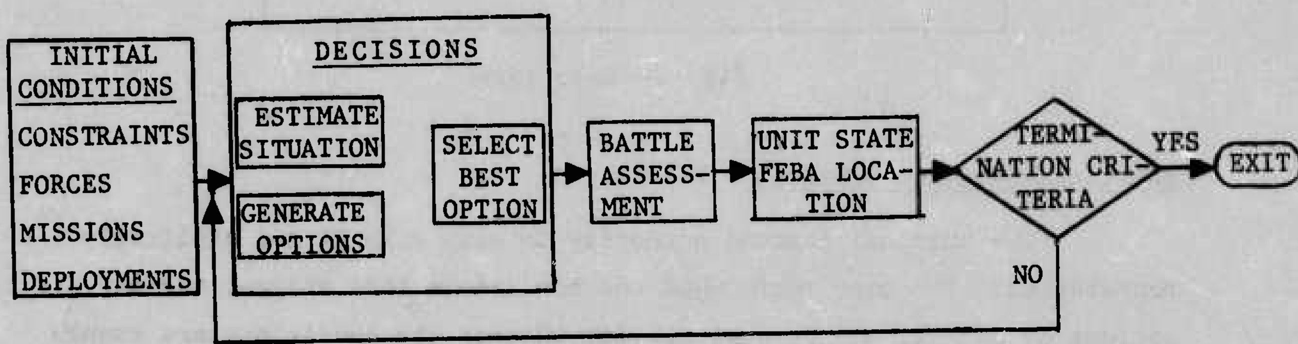

Fig. 1—Overall Structure

MINTSIM has been designed to be a fully automated simulation of a theater campaign in Central Europe.* It is driven by <u>decisions</u>

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* If desired, the program can specify events or conditions for stopping the simulation to allow the user to change inputs in the light of the situation.

made by successive levels of command on both sides. The battle results of these decisions are assessed, the results recorded, transmitted to the commanders in degraded form to reflect the fog of war and the C^3 state of each commander, and the next cycle begins. The process is repeated until specified criteria for ending the campaign are met.

USER INPUT

The four classes of user input are shown in Fig. 2.

- Political Decision Criteria
- Military Decision Criteria and Policies
- Initial Forces, Missions, Deployments, and Arrival Schedules
- Technical Factors

Fig. 2—User Input

Political Decision Criteria

The national command authority on each side is not explicitly represented. The user must input the conditions that trigger nuclear options by each side. He must specify whether the conditions are events or predictions. He must specify whether the use of a nuclear option is discretionary or mandatory. And he must specify the time required for political approval after a trigger occurs or is predicted. MINTSIM does not represent requests for selective employment that are disapproved by political authorities. [Chapter 9, pp. 8-10.]

Constraints on the use of nuclear weapons after approval must also be explicitly represented: numbers, yields, delivery systems, targets, areas, and nationality; and maximum collateral damage to civilians exceeding a given threshold of effects. [Chapter 9, pp. 106.]

Military Decision Criteria

The user inputs a number of military decision criteria by which the commanders at each echelon select their course of action. For ground combat, these criteria concern the relative importance of gain or loss of territory, friendly and enemy casualties, and collateral damage. [Chapter 4, pp. 47-49.]

The user inputs criteria for assessing nuclear risk and ordering ground and air forces to disperse or take other measures to improve their survivability. [Chapter 7, pp. 67-69.]

Initial Forces, Missions, etc.

The user specifies the initial firepower effectiveness and C^3 index (to be described later) for each NATO division and Pact army, the number of nonorganic artillery battalions, the number of aircraft and air bases by type, the number of nuclear launchers and weapons by type, and the initial subordination, disposition, and mission of these forces; and the arrival schedules of reinforcements in each type of force.

Technical Factors

There are a large number of technical inputs to operate the various models in MINTSIM concerning force effectiveness, C^3, the target acquisition, conventional and nuclear assessment. A C^3 index is used to influence many judgments, estimates, decisions and assessments in MINTSIM. It is presently based on the number of alternate headquarters in being and on the relative investments of line units in C^3 personnel and other resources. Because of the pervasive influence of C^3 in MINTSIM, the need for experimentation with these and other factors is suggested before adopting a means of generating the index. [Chapter 6, pp. 1-3.]

OVERALL DECISION STRUCTURE

Figure 3 shows the overall decision structure of MINTSIM.

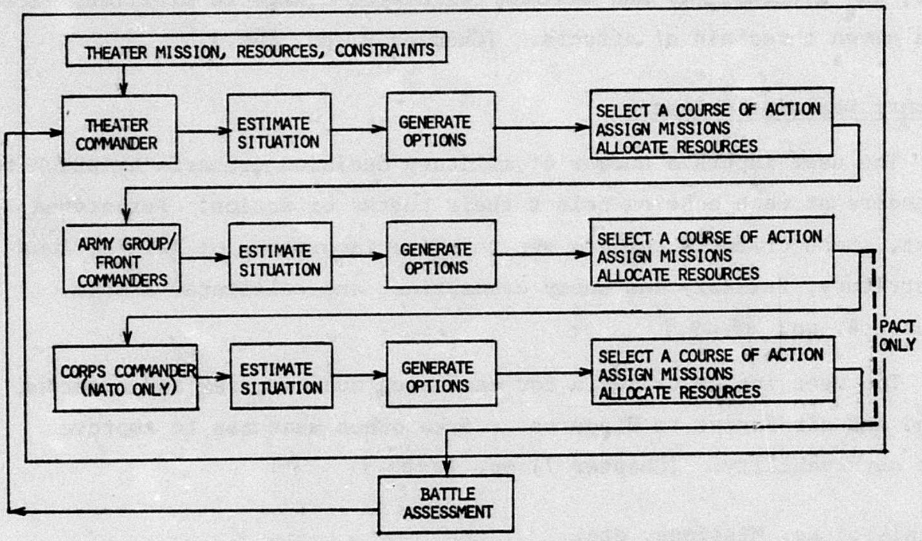

Fig. 3—Overall Decision Structure

The theater commander on each side makes an estimate of the situation, generates a series of allowable options (conventional, nuclear, or both), assesses the contribution of each option to the success of his mission, and selects the best option. He then assigns missions and allocates resources to his next subordinate commanders (army group or front). The army group and front commanders, based on their assigned missions, go through the same process and assign missions and allocate resources to their subordinate corps and armies. Each NATO corps repeats the process, assigning missions and allocating resources to divisions. On the Pact side, the front commander is the lowest decision-maker in order to maintain approximate equality in the number of decision-makers and units on both sides.

All commanders on both sides estimate the situation and make decisions at uniform intervals. For conventional war, 24 hours is a reasonable standard. If nuclear weapons are used, the increased ability of higher commanders to influence the situation requires a shorter decision cycle: 6 or 12 hours at the user's option.

Estimate of the Situation

The estimate of the situation is designed to force the commander to base his decisions on realistic levels of information—normally less than perfect—about his own capabilities and enemy capabilities and intentions.

A commander's knowledge of his own capabilities depends on the state of his command, control, and communications and that of his subordinates. Each headquarters is assigned an initial undegraded C^3 index. As the battle progresses, the initial C^3 index is degraded as C^3 personnel are lost, headquarters are destroyed, or specified events take place, e.g., first use of nuclear weapons, first combat effort by a unit or headquarters, or rupture of a defensive position. [Chapter 6.]

A commander's knowledge of the enemy—on-line forces, off-line forces, and target acquisition—also depends on the C^3 index. The error in the estimate depends on his C^3 index. [Chapter 7, pp. 69-72.]

Off-line ground forces become known to a commander following a delay—after their arrival in his sector—that depends on his C^3 index. [Chapter 7, p. 71.]

Target acquisition of elements of opposing on-line units depends on the situation, how long they have been on-line, and the commander's C^3 index. This estimate affects only the estimated effectiveness of nuclear options against on-line divisions. [Chapter 7, pp. 79-80.]

Option Generation

Conventional Options. MINTSIM recognizes five tactical missions: rupture,* attack, defend, delay, and reserve. Of the four combat missions possible for the estimating commander, his subordinate echelons are limited to adjacent missions in the sequence shown above. If the commander has reserves (second echelon forces), the options include their commitment to reinforce success for attack missions and limit failure for defense or delay missions. If the commander has no reserves, a reserve may be created by withdrawing one or more of the weakest on-line units. The options also include the allocation of close air support and separate artillery battalions to subordinate elements. [Chapter 4, pp. 35-37.]

There is one major override feature to these rules for generating conventional options. If a successful rupture has occurred, the defender must defend to seal off or attack to pinch off the penetration. [Chapter 11, p. 146.]

Nuclear Options. The nuclear options considered here are only those for use against opposing on-line forces. Nuclear attacks on nondivisional nuclear launchers, air bases, etc., are treated separately. The nuclear options are generated in terms of packages, representing a mix of weapons designed to neutralize or destroy one enemy division. Of the packages available to the decision-maker, they are allocated to the weakest defenders (strongest attackers), up to the limit of the capability of each in turn. [Chapter 4, p. 36.]

Selecting a Course of Action

Each allowable option is evaluated with a simplified assessment model to estimate five performance measures. These five performance measures are weighted according to the assigned mission of the estimating commander. The weighted sum of the five measures is added to obtain a measure of mission success (MMS) of that option. The option with the highest value is selected.

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* A rupture is here defined as a penetration through the depth of a divisional defensive position that has been widened to permit reserves of division strength to pass through and begin exploitation.

The predicted MMS will not be the same as the actual MMS because the commander has used estimates of his own and enemy capabilities rather than the true capabilities.

Performance Measures. [Chapter 4, pp. 7-15.] The MMS model allows the user to select any set of performance measures he wishes. They must, however, be sensitive to the system of MINTSIM missions and political constraints. The following measures are suggested for initial use:

E_1 - Control the defensive zone.

E_2 - Control area forward of a critical line.

E_3 - Conserve own capability.

E_4 - Degrade enemy capability.

E_5 - Minimize collateral damage.

Each E varies between zero and one. Zero represents the worst possible outcome, and one the best possible outcome, for the estimating commander.

Controlling the defensive zone is defined in terms of the depth of the defensive zone of on-line defending divisions. E_1 (for the defender) is the fraction of that depth that remains in the defender's hands at the end of the period. E_1 (for the attacker) is the fraction he has secured. If the attacker has advanced the entire depth in a single period, a rupture has occurred.

The area forward of the critical line is defined as the distance from the initial FEBA to a critical line, which, if lost, ends the simulation. E_2 (for the attacker and the defender) is the fraction of that distance under his control.

Own capability is defined as the combination of firepower and C^3 and supply into a single combat effectiveness value. E_3 is the fraction of the estimated capability at the beginning of the period that remains at the end of the period.

The enemy's capability is defined in the same manner. E_4 is the fraction lost during the period.

(U) Minimize collateral damage is measured by comparing civilian casualties inflicted with a tolerable upper limit. E_5 then becomes

$$1 - \frac{\text{estimated civilian casualties}}{\text{tolerable civilian casualties}} .$$

Mission Weights. [Chapter 4, p. 15, 16.] The user assigns weights (the sum of which must add to one) representing the importance of each measure to the success of the estimating commander's mission. The weights are assigned according to the following guidelines:

Mission	Importance
Rupture	Control of defensive zone dominates all others; conserving own capability of little importance.
Attack	Control of defensive zone and control of area forward of critical line of equal importance; degrading enemy capability more important than conserving own.
Defense	Control of defensive zone dominates; conserving own capability less important than degrading enemy capability.
Delay	Conserving own capability dominates; but control of area forward of critical line more important than others.

OTHER THEATER COMMANDER DECISIONS

The hierarchical decision model applies only to the ground battle (conventional or nuclear). The theater commanders on both sides make a number of other decisions that may limit the resources available

to subordinate commanders and affect the outcome, but do not otherwise affect subordinate commanders' decisions. These decisions are shown in Fig. 4.

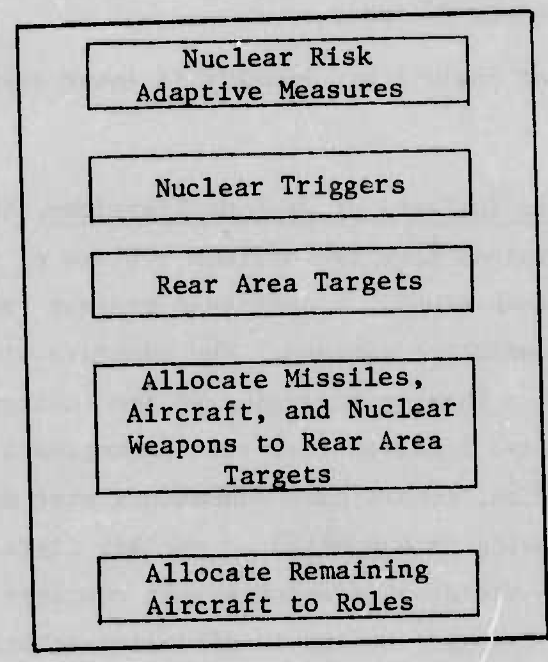


Fig. 4—Other Theater Commander Decisions

Nuclear Risk [Chapter 7, pp. 67-69.]

Only the theater commanders on both sides assess the risk that the enemy will use nuclear weapons. Two states of risk are represented: low and high. The factors contributing to risk assessment are positive when they indicate a high risk, negative when they indicate a low risk. A high risk exists when the positive factors outweigh the negative factors.

Adaptive Measures [Chapter 5.]

When a high risk exists, the theater commander orders adaptive measures through the theater. Adaptive measures increase survivability

from nuclear attack at the expense of conventional effectiveness. The following adaptive measures are taken in a high-risk situation:

- Dispersal of aircraft from developed air bases to primitive air bases (strips or autobahn stretches without facilities). Penalty is reduction in sortie rate and poorer C^3 index.

- Dispersal of logistics. Penalty is lower supply rate.

Zone of Action (Sector) of On-Line Divisions. [Chapter 5, pp. 54-55.] On-line divisions have two minimum sectors or zones of action (which may differ for each side): a doctrinal minimum that can never be violated, and a larger adaptive minimum. The adaptive minimum may be ordered in only part of a theater according to the theater commander's assessment of the relative importance of the conventional penalty and nuclear risk. In addition, subordinate commanders must order the adaptive minimum for divisions using or supported by nuclear fires. Zone of action (ZOA) and sector define the area in which a unit operates and for which it is responsible. ZOA usually refers to offensive action; sector refers to defensive action. ZOA is used in this report to include both terms.

Nuclear Triggers [Chapter 9, pp. 110-112.]

A nuclear trigger specifies the events or predictions when the commander examines nuclear options. Until a trigger is activated, no nuclear options can be examined. The user may specify that nuclear options in the MMS system are mandatory or discretionary. If it is mandatory, conventional-only options are prohibited in the MMS system; if it is discretionary, a conventional-only option may be adopted if its MMS is higher than any nuclear option.

There is one condition when a trigger does not cause nuclear options to be examined. The user may specify, for a particular trigger, that the political decision time is greater than a decision cycle. In the decision period, only conventional options may be examined.

The following triggers are suggested:

- Rupture in at least one corps (NATO)
- Distance to critical line less than __ km (NATO)
- Distance to critical line greater than __ km after __ days (Pact)
- Sortie rate of nuclear-capable aircraft less than ___ (NATO)
- Enemy use of nuclear weapons (NATO and Pact)
- Specified by user.

Rear Area Targets [Chapter 7, pp. 72-79.]

MINTSIM combines the theater commander and all subordinate air force commanders on each side. In addition, he includes subordinate army commanders in decisions to use nuclear missiles against rear area targets. Decisions to attack rear area targets are made, therefore, only by the theater commander.

There are seven classes of rear area targets: nuclear custodial units and two classes of missiles; air bases, headquarters of corps/army and above; off-line divisions and armies; and supply. A theater target list is generated each day based on a percent of knowledge multiplied by off-standard numbers of reconnaissance sorties, Sigint capabilities, and the theater C^3 index. The latter reflects the transmission of data from national intelligence assets. Non-reacquired targets may be added to the list from previous lists according to a theater retention policy.

The list includes false targets: physical or electronic dummy targets, misidentifications, and unrecognized movement of previously acquired targets.

Assignment of Weapons and Delivery Systems to Targets

The target classes, including on-line divisions, are assigned a priority for attack. If political constraints prevent any attack of a target class, it is deleted from the list. If any or all of the remaining targets cannot be attacked with nuclear weapons, conventional weapons are assigned. The method of assignment is to attack targets in order of priority with the smallest warhead (including conventional) that achieves a prescribed damage expectancy. The method is as follows:

1. In order of priority, the user inputs the fraction of acquired targets in each class that may be struck up to the lesser of the permitted number of weapons or the number of targets.

2. The user supplies a nuclear damage expectancy (DE) table that provides the DE for each yield-delivery system-target combination, and a minimum DE below which no nuclear target attack will be made.

3. The user also supplies a conventional damage expectancy table for each weapon-delivery system-target combination.

4. Those targets where conventional attack by n sorties exceeds the minimum DE are transferred to the conventional target list.

5. The remaining targets are assigned the lowest yield meeting the minimum DE, using short-range missiles first (if allowed), medium range missiles second (if target is within range), and aircraft last.

6. If weapons remain, the MMS system is operated to determine whether and how many weapons are required (up to the political limit) for attacks of engaged forces.

7. If weapons remain unassigned within the political constraints, the same system is used to assign these weapons to targets of lower priority than on-line forces.

Assignment Override

If certain events occur or are predicted, the assignment scheme is overridden by a panic mode. The panic mode gives an absolute priority to one target class.

If a successful rupture occurs in one or more corps, all aircraft capable of close air support are assigned close air support missions. All nuclear weapons, within political constraints as to number, yield, etc., are assigned in packages to subordinate commanders. The MMS system is operated first. If any nuclear weapons and aircraft remain, they are assigned to rear area targets in order of priority as described.

BATTLE ASSESSMENT: GENERAL

The sequence of battle assessment is shown in Fig. 5.

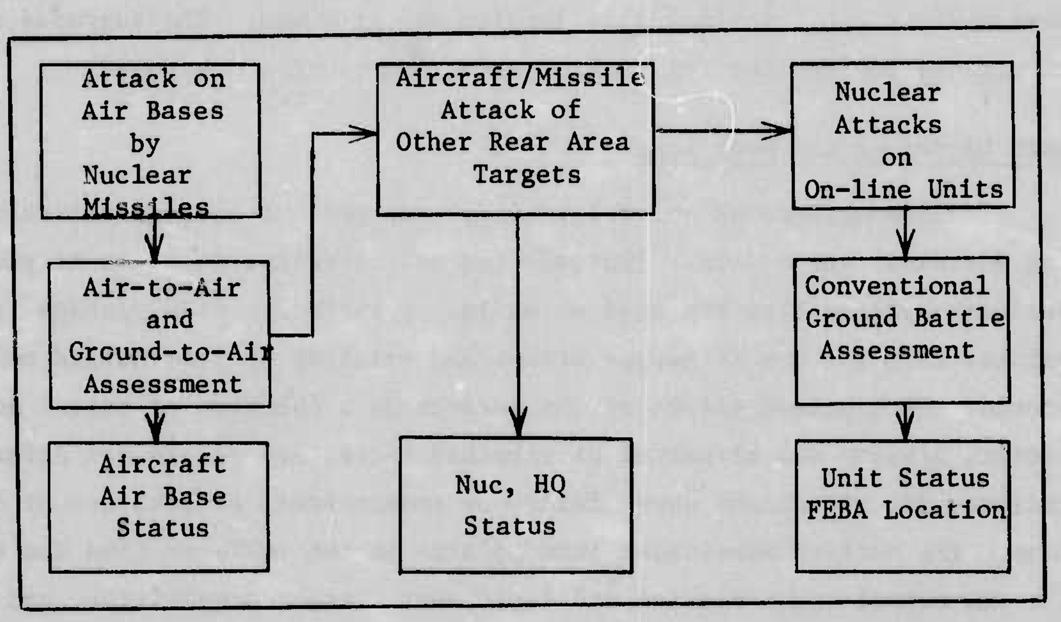


Fig. 5—Battle Assessment

If nuclear missile attacks on air bases are allowed, they are assessed first. The remaining aircraft are then assessed to determine en route attrition and the results of nuclear and conventional attacks on air bases by aircraft. These results then modify the aircraft and air base status files. Nuclear missile and conventional/nuclear aircraft attacks on other rear area targets are then assessed and the results modify the status files of nuclear launchers, custodial units, headquarters, etc. Nuclear attacks on on-line forces are then assessed, which provides an input to the following conventional battle. The conventional battle assessment results in FEBA movement, casualties, change in C^3 index, etc., of opposing on-line forces.

BATTLE ASSESSMENT: NUCLEAR

Rear Area Targets

Assessment of targets other than division is accomplished by damage expectancy tables for yield-delivery system combinations, degraded by the actual theater C^3 index, en route attrition of aircraft, and reliability of missiles and warheads. Attacks on false targets cause collateral damage but have no military effect. Except for NATO divisions and Pact armies, rear area units are not individually located and attacked. The degraded damage expectancy defines the fraction of each target class destroyed.

NATO Divisions and Pact Armies

Individual weapons and delivery systems are not used to attack opposing divisions and armies. Instead, the user develops packages of yield and delivery systems that are used as units. A table for each package is developed with the use of target arrays and existing nuclear damage models to provide the combined effect of the package as a function of target acquisition, mission and dispersal of attacked force, and damage and defeat criteria for situations where follow-up conventional attacks are or are not made. The nuclear assessment interpolates in the table to find the result for the actual enemy mission and deployment, target acquisition, and possible inability to deliver the whole package. The nuclear effects (casualties, C^3 index) modify the effectiveness of the target force in the ensuing conventional battle, delay its arrival if it is scheduled to reach the FEBA

in the ensuing period, or modify its status, if its mission is to remain off-line.

AIR BATTLE

Air-to-Air Battle [Chapter 8, pp. 90-93.]

After allocation, all penetrating aircraft (reconnaissance, counter-air, interdiction and deep air support, and escort) encounter enemy air defense interceptors. Friendly escorts engage enemy interceptors. If there are more interceptors than escorts can handle, they engage ground attack aircraft. The latter aircraft jettison their ordnance (if nonnuclear) and engage. If the aircraft carry nuclear weapons, they seek to escape and continue to the target. A single attrition probability is used to represent the entire intercept process against all penetrating aircraft, which depends on the theater C^3 index. At the user's option, the attrition probability for aircraft carrying nuclear weapons may differ from that for aircraft carrying conventional weapons. All aircraft not engaged proceed on their missions. All surviving engaged aircraft return to base.

Ground-to-Air Battle [Chapter 8, pp. 93-94.]

Aircraft penetrating interceptor defenses then encounter ground-to-air defense systems. Interdiction and deep support aircraft encounter different SAM and ADA units than close air support aircraft; thus different attrition probabilities will be used.

Counter-Air Battle [Chapter 8, pp. 94-96.]

Aircraft are distributed over developed and primitive air bases in proportion to the daily sortie capability of the bases. Aircraft on developed air bases are in shelters up to the number of shelters specified for developed air bases. All other aircraft are in the open. The number of aircraft at risk to missile attack depends on the sortie rate and sortie duration. The number of aircraft at risk to aircraft attack is the same with the addition of a warning factor, which is degraded by the theater C^3 index. Aircraft lost on bases are separately calculated for sheltered and unsheltered aircraft for conventional and nuclear attack.

Close Air Support [Chapter 8, p. 97.]

Close air support losses are then calculated for the aircraft supporting each NATO division and Pact army as a function of the mission and the number of enemy SAM and ADA units in the opposing force.

The contribution of close air support is converted to effectiveness units similar to that of ground nondivisional artillery. The firepower effectiveness, however, is modified by combining the theater C^3 index and the C^3 index of the supported force.

GROUND BATTLE MODEL

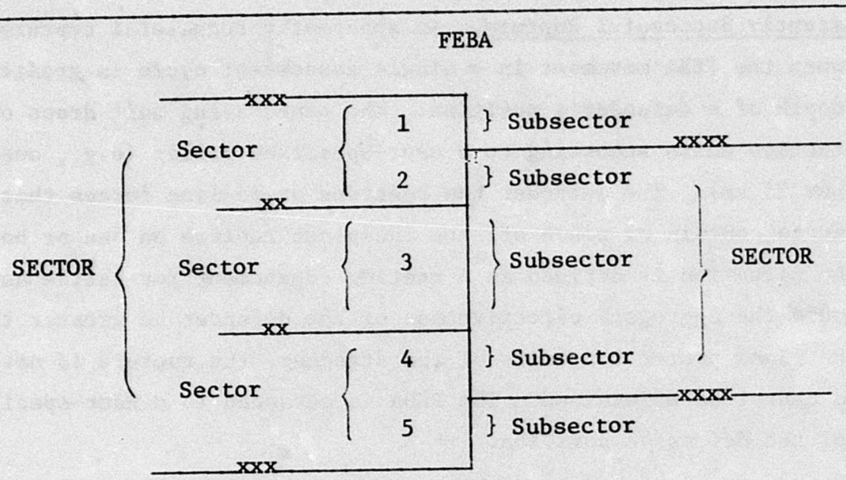
Geometry of the Battlefield

Coordinate System. MINTSIM uses the same battlefield representation as the Concepts Evaluation Model (CEM). The initial FEBA is drawn on a map. Perpendicular to this FEBA, lines are drawn representing the planned movement of the forces. These lines may not intersect, but their separation may expand and contract. The compiler then interpolates minisectors between these lines. The resulting grid is the coordinate system.

Terrain and Population. The battlefield is divided into four classes of terrain, which affect trafficability and FEBA movement, and four classes of population density which affect collateral damage.

On-Line Forces. Forces on each side have a sector on the FEBA which is defined by the FEBA location and the number of minisectors in the unit's sector. Since the boundaries of friendly and enemy units rarely coincide, the distance along the FEBA of a given unit's sector occupied by an opposing unit is a subsector.

Figure 6 shows an example of sectors and subsectors.



There are five subsectors.
The left-hand force has one corps and 3 division sectors.
The right-hand force has one army sector and portions of two other army sectors.

Fig. 6—Sectors and Subsectors

The conventional ground battle is assessed by subsector.

Casualties and FEBA Movement

There are many casualty and FEBA movement assessment schemes for theater-level warfare. The MINTSIM specifications are not geared to any particular scheme as long as it meets the following requirements:

- sensitive to missions assigned opposing forces
- sensitive to gross terrain classes
- depends on ratio of effectiveness of opposing forces
- effectiveness ratio can be modified by C^3 index of opposing forces.

Rupture and Envelopment [Chapter 11, pp. 145-149.]

Apparently Successful Rupture. An apparently successful rupture has occurred when the FEBA movement in a single assessment cycle is greater than the depth of a defender's position. The penetrating unit drops off flank protection units according to a user-specified policy (e.g., one division per 25 km). The defender has reserves or on-line forces that can be diverted to contain or pinch off the incipient rupture on one or both sides. The situation is defined as a meeting engagement for battle assessment. Should the aggregate effectiveness of the defender be greater than that of the flank protection units of the attacker, the rupture is not viable and cannot be maintained. The FEBA is advanced to a user-specified fraction of the defensive position.

Successful Rupture. If the defender's force available for pinch-off has less effectiveness in the assessment period than the attacker's flank protection forces, the rupture is successful, the FEBA is advanced to the previously calculated distance, and the width is increased to the lesser of the attacker's sector or a user-specified minimum breakthrough width. The defending units in this breakthrough zone will lose a specified fraction of personnel, supplies, and C^3 effectiveness. (This fraction is based on judgment and historical data as available.)

Decisive Rupture. If the rupture cannot be contained or pinched off in the next cycle, it becomes decisive and the MINTSIM simulation terminates.

Envelopment. Although the flow lines of the MINTSIM geometry cannot intersect, the following scheme makes possible a crude representation of an envelopment. If two successful—but not decisive—ruptures occur, an envelopment may be possible. Envelopment occurs when the depth of the shallower penetration is greater than a user-specified fraction of the distance between penetrations. The defending units are encircled, become ineffective, and a user-specified fraction escape as individuals and become available as replacements. The new FEBA is moved to the depth of the shallower penetration.

IMPROVING UNIT STATE [Chapter 10]

Reinforcements

Reinforcements arrive in the theater according to user-defined schedules. The day before their availability for commitment, they become part of the theater reserve to be allocated according to the MMS system, if they are ground combat units. Nuclear weapons, aircraft, and nuclear launchers increase the status files, since they are not specifically located or identified.

If the user desires, non-US, non-UK reinforcements can be targets for Soviet attack prior to their availability for commitment.

Reserves

Reserves (second echelon forces) may be committed or reconstituted by removing on-line forces. Theater reserves take 2 days to reach the FEBA; army group reserves/front second echelon armies, one day; and corps reserves can be committed in less than one day.

Resupply

Resupply is kept by a single index in tons for each unit represented. Each type of unit has a normal and a critical supply level. If a unit's supply is below the critical level, its effectiveness is zero. Supply priorities depend on whether a unit's actual level is above or below the critical level. The rate of resupply may be degraded by the adaptive measure of logistic dispersal and by a poor C^3 index.

Replacements

Replacements arrive in the theater at a user-specified schedule. For both sides, they are defined as infantry/armor, artillery, C^3, and other. These replacements are allocated to represented units in proportion to their shortages. Priorities can be established in a similar manner to that for supplies. The policies for the two sides need not be the same. The Soviets, for example, may replace C^3 personnel on an individual basis, but reconstitute other units.

Reconstitution

Units whose unit capability falls below a specified value must be withdrawn into theater reserve. They may not be committed until their capability is greater than a threshold value and their supply level is above critical.

Chapter 3

ECHELONS OF COMMAND

GENERAL

Three echelons of command are represented on the NATO side (theater, army group, and corps). Two echelons are represented on the Pact side (theater and front). Units below NATO division and Pact army are not represented.

The asymmetry in levels of command represented in MINTSIM arises primarily from relative numbers of units. With the asymmetry NATO has 11 headquarters represented, the Pact four. If Pact armies were included, Pact headquarters would total approximately 24 and MINTSIM running time would be more than twice what the asymmetric treatment requires. Furthermore, there are approximately 30 NATO divisions, 20 Pact armies, and 85 or so Pact divisions. The asymmetric solution to the levels of decision keeps the number of basic maneuver units approximately equal and manageable from a time and bookkeeping standpoint.

The decisions made at theater level on each side represent not only decisions made by the theater commander, but decisions coming from his higher headquarters: National Command Authorities (NCA), North Atlantic Council (NAC), or the Pact equivalent (STAVKA). No attempt is made to model the political decision process of the NCA, NAC, and STAVKA, but the military constraints and requirements of those decisions are introduced at the theater echelon.

Decisions are made by all echelons at fixed intervals; every 24 hours until the first or resumed use of nuclear weapons occurs, and every 6 hours thereafter until the first period occurs in which nuclear weapons are not used. Different echelons make decisions for different forecast periods; theater, for four days; army group/front, for two days; and NATO corps for one day. The criterion for how far ahead to look is that decisions should be under implementation by subordinate units by the end of the period. It is desirable, but not essential, that periods be multiples of period of subordinate units.

THEATER LEVEL

The consequences of decisions made at NCA, NAC, or STAVKA level are included in the theater commander's decisions in the form of constraints and requirements, as specified by the user. For example, the user may specify, when permitting consideration of the use of nuclear weapons, that particular geographic areas may not be attacked or that only specified delivery means may be used.

Decisions made by the theater commanders for each side include:

- assignment of reinforcing units
- allocation of replacements and supplies
- assignment or positioning of theater reserves
- assignment of delivery means and weapons to rear area targets
- allocation of tactical air among roles
- assignment of missions to AG/fronts
- allocation of combat air support (CAS) sorties among AG/fronts
- allocation and authorization of nuclear weapons packages to AG/fronts

- initiation or cessation of adaptive measures related to:
  - attack of enemy nuclear weapons and delivery means
  - intelligence priorities (relative emphasis on enemy conventional and nuclear forces)
  - aircraft basing (developed or primitive; in-theater or removed)
  - nuclear weapons supply area (SASP) locations (readiness vs decreased vulnerability)
  - withholding nuclear delivery means
  - C^3 matters (limitations on use, special protection against EMP, etc.
  - division/army minimum zone of action (ZOA).

Adaptive measures represent decisions made by theater commanders only and are based on his assessment of the risk that the enemy may use nuclear weapons in the forecast period. Adaptive measures are discussed more fully in Chapter 5.

Adaptive measures are selected only at theater level because only the theater commander is sufficiently informed to judge the imminence of nuclear use and because most adaptive measures transcend corps and army group boundaries. The measure pertaining to minimum ZOA for divisions is made on a corps-by-corps basis, since the use or likely use of nuclear weapons against maneuver units may not be considered uniform throughout the theater.

ARMY GROUP/FRONT LEVEL

NATO army group and Pact front commanders make the following decisions:

- assignment of reinforcing units
- allocation of replacements and supplies
- assignment or positioning of AG reserves

- assignment of missions to corps/armies
- allocation of CAS to corps/armies
- allocation of separate artillery units among corps/armies
- allocation and authorization for use of nuclear weapons packages to corps/armies.

The front level is the lowest Pact level at which decisions are represented in the model. Pact armies are considered to act in established patterns once their ZOAs, resources, and missions have been determined by the front. On the NATO side, decisions are represented at the corps level and NATO divisions act in established patterns once their ZOAs and missions are determined by corps.

CORPS LEVEL (No Pact Equivalent Representation)

The NATO corps commander makes decisions comparable to those made at AG. He:

- allocates replacements and supplies
- assigns or positions corps reserves
- assigns missions to divisions
- allocates CAS sorties among divisions
- allocates nondivisional artillery among divisions
- allocates and authorizes use of nuclear weapons to divisions.

SUMMARY

NATO command levels represented are theater, army group, and corps. Pact levels are theater and front. The smallest maneuver units represented, NATO divisions and Pact armies, do not have decision processes represented, but are assumed to respond in predictable fashion once their missions, resources, and ZOAs are set.

Most decisions are made in accordance with user-supplied rules or criteria; those affecting mission selection, reserve commitment, CAS and fire support, and nuclear weapon package allocation and authorization are made in a model which is described in the next chapter.

Chapter 4

SELECTING A COURSE OF ACTION

GENERAL

This submodel is referred to as the MMS submodel, since it is in this submodel that the simulation selects for adoption that option which maximizes the measure of mission success. The MMS submodel is the most innovative and powerful tool which has been added to existing simulations and permits the MINTSIM user to choose among permissible options with appropriate consideration of the interactions among nuclear usage, conventional firepower, and maneuver. As an input to a simulation, the user assigns weights for each mission to each goal of combat which he considers to be important. During the run the model estimates the likely outcome of each permissible course of action in each effect sought and chooses that course of action which maximizes the command's prospect of successfully accomplishing the mission assigned to it.

Existing models select a single measure of performance, typically the number of kilometers of FEBA movement (movement of the forward edge of the battle area) in unit time, as the measure of mission success. Other measures of performance are reported as a function of time, but do not contribute directly to the ranking of alternative forces, hypotheses, or courses of action. In some models these other measures of performance serve to exclude particular courses of action from further consideration; for example, a defensive course of action which would result in X percent casualties may be unacceptable even though it does yield less ground than other courses of action.

A simulation needs an unambiguous measure of effectiveness or merit by which each option can be measured. MINTSIM provides in the MMS submodel such a measure which takes into account every aspect of the outcome of combat which the user considers important, weights each according to the user's desires in the light of the unit mission, assesses probable performance in each area of outcome, and assigns an aggregate performance number to each course of action. The course of action with the highest performance number is adopted. Whether permissible options shall or may include nuclear-usage options is determined by the theater commander, based upon his current knowledge and his estimate of actions likely to occur during the next period and in the light of the nuclear thresholds, constraints, and requirements laid upon him by his controlling authorities. The probable performance by the unit is estimated, based upon information available to the commander and against the enemy course of action considered by the friendly commander to be most likely. Evaluated unit performance may differ from estimated unit performance because of information errors or because the enemy does not follow what is considered to be his most likely course of action. The MMS submodel, then, does not guarantee a successful option or even the most successful available option, but rather the choice of that permissible option which it is estimated will be most successful.

PREPARING PERMISSIBLE COURSES OF ACTION OR OPTIONS

The major uncertainty affecting the list of permissible options is whether nuclear usage may be included in some of the options. This determination is made daily for each side by the theater commander who it will be remembered, represents the NCA as well as himself. Other decisions, made by each command level, affecting the list of options concern how available combat air support sorties and available conventional fire support means (CAS/FS) will be allocated among subordinate units, what combat mission and zone of action (ZOA) will be assigned to each on-line unit, what mission and ZOA or position will be assigned to

the reserve(s), and what number of available nuclear packages will be assigned to each on-line unit. These decisions are made in the MMS submodel for each command represented, each period. They are based upon the mission resources and ZOA assigned to the command and are in accordance with user input criteria.

The major decision——whether nuclear usage options will be considered—is made by the theater commander each period. The user will have furnished specific conditions or nuclear thresholds which require or permit the consideration of nuclear options. The thresholds may be event-dependent or arbitrary. For example, the user may specify that nuclear options may be considered if the theater commander estimates that at least two corps defensive zones will be overrun in the next period. Or the user may require that the attacker will use nuclear weapons if he has not reached a certain phase line by a specified time. Nuclear thresholds are discussed in detail in Chapter 9, pp. 110-112.

In determining whether nuclear thresholds have been met, the theater commander bases his determination on information presently available to him and upon his estimates of the likely outcome of the next battle period. The theater commander looks ahead periodically at the next four days of conventional battle; the next day, if nuclear weapons have been used or are being introduced. His estimates are affected by the quality of his target acquisition and his C^3 index. See Chapter 7, pp. 69-71, for details.

Nonnuclear variations are combined mechanically to form a full matrix of possible options. The user limits variations of each element to the minimum considered essential for examination, since the total number of options increases geometrically and exponentially. With four subordinate units and four tactical missions for each unit, there are 256 possible unit/mission combinations. For each of these, there are two ways of allocating fire support and close air support and three ways of allocating nuclear packages, for a total of 1,536 different options.

Each run will be limited to a choice between two alternatives for allocating CAS/FS. The user selects alternative allocation policies, with different ones for different missions. Policies might be, for example: a specified large percentage of available CAS/FS to the unit having lowest (highest) FR relative to enemy in his ZOA with the balance divided equally among other units; or, the large percentage to the least successful unit (one losing most or gaining least ground) in the preceding period and the balance equally.

Allocations of nuclear packages are used by on-line units against on-line units in the friendly unit's ZOA. One package is capable of rendering a division-sized unit ineffective even when target acquisition is poor. If two packages might be allocated to a unit, the choices might be two to weakest defender (strongest attacker), one to each of the two weakest (strongest) units, or one to weakest (strongest) and the other held for possible use in the next period.

MINTSIM considers five tactical missions: delay, defense, attack, rupture, and reserve. As will be developed later, the user can vary the intensity of the defense, delay, attack, or rupture by varying the weights he ascribes for a given simulation. Of the four missions possible for on-line units in MINTSIM, the model limits choices to not more than three: the same mission assigned to the parent unit and the missions next to it in the sequence delay, defend, attack, rupture. Table 1 shows the missions for on-line units.

Table 1

MISSIONS EXAMINED FOR ON-LINE SUBORDINATE UNITS

Mission Assigned to Parent Unit	Missions Examined in Subordinate Units On-Line
Rupture	Rupture and Attack
Attack	Rupture, Attack, Defend
Defend	Attack, Defend, Delay
Delay	Defend, Delay

The reserve is not given an on-line mission if the decision-maker can successfully attack without it, but could not rupture with it, or if on-line units can successfully defend without its commitment. The criteria for judging these conditions to exist are different at different decision-making levels. Thus, at theater level reserve units would not be committed if the ratio of attacking on-line forces to enemy forces was at least, for example, 1.9:1, but less than 2.6:1 (where addition of reserve might give successful rupture). At front/army group level, comparable numbers might be more than 2.4:1, but less than 3.0:1; at corps they might be more than 2.7:1 but less than 3.6:1. Application of these two simplifying rules for not using the reserve should eliminate in the range of 300 options from consideration at theater level without doing violence to the nature of the simulation outcome. Experimentation and study will show the proper threshold values and the extent of the change in simulation outcome.

Reserve units are limited to the missions possible for on-line units or to the reserve mission. To limit the number of options to be examined, the reserve unit (or units) is (are) assigned to an on-line unit (or to two units) which then receives a single mission and ZOA, but which has a strength and effectiveness equal to the sum of its components. Elements of the combined unit are assumed to be uniformly located laterally in the ZOA for damage assessment. On-line units may be transferred to reserve, but the transfer is accomplished by the process described in Chapter 10, pp. 127-128, and occurs before the preparation of options for the MMS takes place.

The mechanical process of option generation then occurs as follows:

- from parent unit mission, determine permissible missions for on-line units (Table 1)
- from FR of parent unit, determine whether reserve will be used on-line
- from estimate-of-situation, determine whether nuclear options are to be examined

- for each reserve/nuclear package/CAS/FS combination to be examined, determine the changes (if any) in unit ZOA from rules on ZOA change in Table 2.

Table 2

CHANGES IN ZOA FOR ON-LINE UNITS

Event or Prediction	Changes in ZOA
1. Minimum ZOA has been announced.	Expand to the minimum the ZOA of any units having narrower ZOA, starting at North. If necessary, pull units off line into reserve. Where each adjoining unit has ZOA greater than minimum, expand in direction of unit having lower FR (delay, defend), higher FR (attack, rupture).
2. Successful rupture has occurred.	If 2 or more units in one direction have elements within x km of edge of rupture, expand the contiguous unit ZOA to a zone which achieves the user-supplied emergency defense force ratio.
3. Reserve unit commitment or nuclear package, or panic mode allocation of all available CAS/FS planned into unit sector.	Expand ZOA of reinforced unit at expense of neighboring unit which has the lower post-nuclear FR in defense/delay or the higher in attack/rupture. Set ZOAs in defense or delay at values which will equalize the post-nuclear FRs in the modified ZOAs to the extent possible; in attack or rupture at the values which maximize FR in the reinforced unit within ZOA constraints.

- list the options for the subordinate unit in lowest-numbered minisector taking, in turn, each permissible mission, employ other on-line units in every permissible mission in combination with both CAS/FS possibilities and with each permissible nuclear alternative, and the

reserve unit(s) committed and uncommitted. Then repeat option generation with the reserve committed to subordinate unit in lowest-numbered minisector. ZOAs are only adjusted in accordance with the rules in Table 2.

- repeat process with remaining units subordinate to decision-maker.

A listing of options to be considered can, then, be generated automatically by the computer for every period, given the mission of the parent unit; the theater commander's determination of whether nuclear usage options are to be considered; and user input as to permissible missions, ways to allocate CAS/FS and nuclear packages. How to choose one of the alternatives is described later, following a description of the criteria for choice.

CRITERIA FOR CHOICE

Every commander has options about what the goals of combat are and what their relative importance is under different conditions. For example, "they shall not pass" was the goal of Horatius at the Bridge, whereas preservation of his force was foremost in the mind of Chief Joseph of the Nez Perce on his long march. MINTSIM requires, as an input, that the user specify goals in combat and indicate their relative importance for each of the four missions (both in conventional and during nuclear usage.

The goals specified should have two characteristics: the measure of performance, E, in achieving each goal should be determinable on a scale of 0 to 1.0, and desirably the goals should be independent of each other.

Suggested goals in combat are:*

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* Identification, not priority, is indicated by the number; importance will be discussed later.

1. Control the defensive zone.

2. Control area forward of critical line.

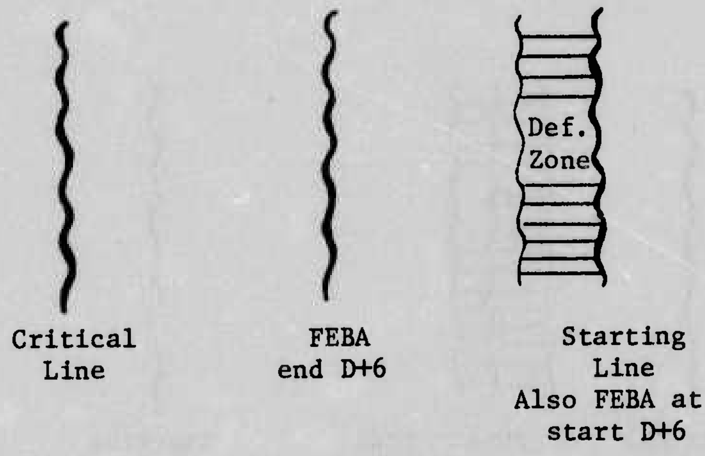
3. Conserve own capability.

4. Degrade enemy capability.

5. Minimize collateral damage.

"Control the defensive zone" relates to dominance of the depth of the principal defensive area of on-line defending or delaying division-sized units. This is considered in MINTSIM to be x km deep, measured from the FEBA at the start of the period. A defender fully achieves his goal ($E_1 = 1.0$) if he controls all x km at the end of the period (EOP), whereas the attacker or rupturing unit measures his performance toward this goal by the fraction of the x km he controls at EOP. E_1 of defender and E_1 of attacker in a given subsector, then, can be seen to be complementary.

The goal "control of the area forward of a critical line" relates to control of territory along the shortest line in the unit ZOA from a starting point (usually the forwardmost NATO defensive position) to a critical line (for example, the Weser River). The critical line usually is a line whose loss to a defender or control by an attacker would be decisive in the theater campaign. Unlike E_1 which is calculated as progress during one period, E_2 is cumulative progress since the war started. The theater commander considers enemy units which can be employed within four days, and estimates the worst E_2 that may occur within the theater in four days. He will forecast a different E_2 than do the Army Group and Corps commander who look at forces usable within two days and one day respectively.

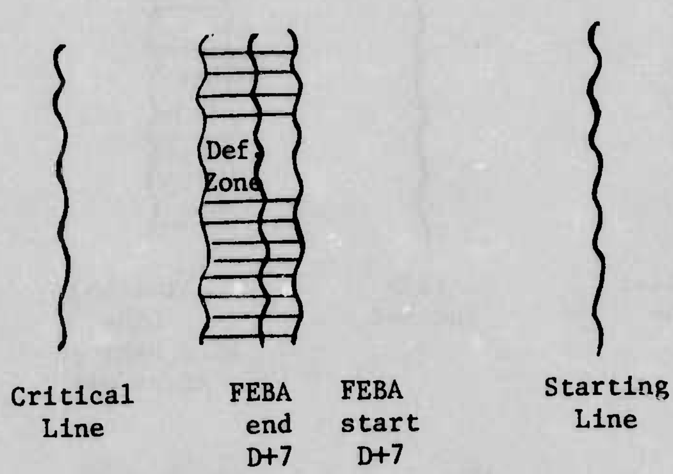


ATKR E_1 = 1.0 DEF E_1 = 0

ATKR E_2 = .55 DEF E_2 = .45

Fig. 7—D+6 Situation

Figure 7 shows the D + 6 situation: the critical line, the starting line, defensive zone and FEBA at beginning and end of the period. On D + 6 the attacker has overrun the entire defensive zone, hence his E_1 = 1.0 and defender's E_1 = 0. Attacker has progressed a total of .55 of the distance from starting line to critical line; hence attacker's E_2 = .55 and defender's E_2 = .45.



ATKR E_1 = .45 DEF E_1 = .55

ATKR E_2 = .62 DEF E_2 = .38

Fig. 8—D+7 Situation

Figure 8 shows illustrative results for the same situation on D + 7. Attacker has not overrun or ruptured the new defensive zone, but has an E_1 for D + 7 of .45. In so doing, attacker has made additional progress toward the critical line and his E_2 is now .62. (If attacker were to be driven back tomorrow, his E_1 at end of D + 8 would be less than .62.) Like E_1, E_2 values for the opponents are complementary in any subsector. They will be complementary for larger units, however, only when boundaries coincide.

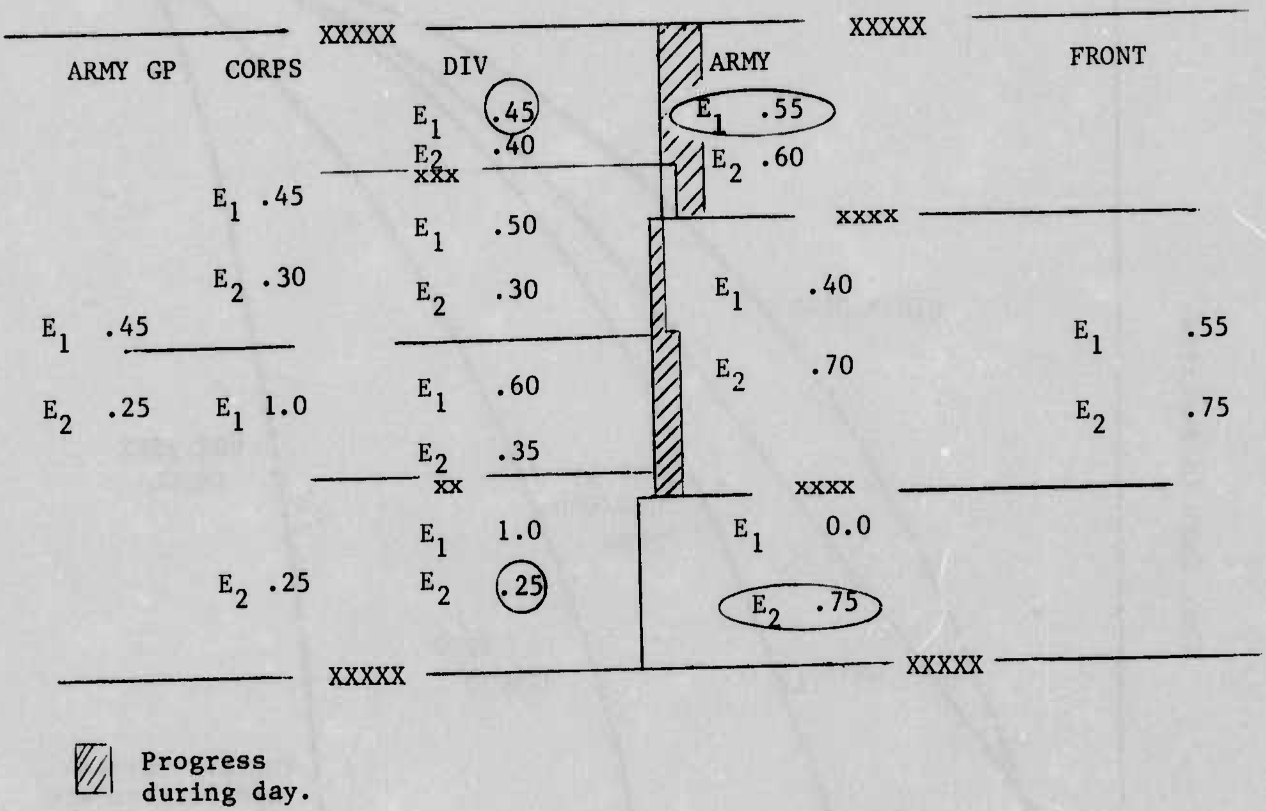


Fig. 9—E_1 and E_2 Values, Higher Units

As illustrated in Fig. 9 where E's are shown for three command levels in defense and two in attack, a defending higher unit adopts as its measure the lowest E_1 and E_2 of any of its subordinate units, while an attacking unit adopts the highest values found among its subordinate units.

The goal "conserve one's own capability" involves retention of personnel, materiel, supplies, and C^3 and TA capability. MINTSIM proposes to represent these capabilities by the relationship of unit capability to surviving personnel of four types: combat (armor and infantry), artillery, C^3 personnel, and others. The relationships are shown in Fig. 10.

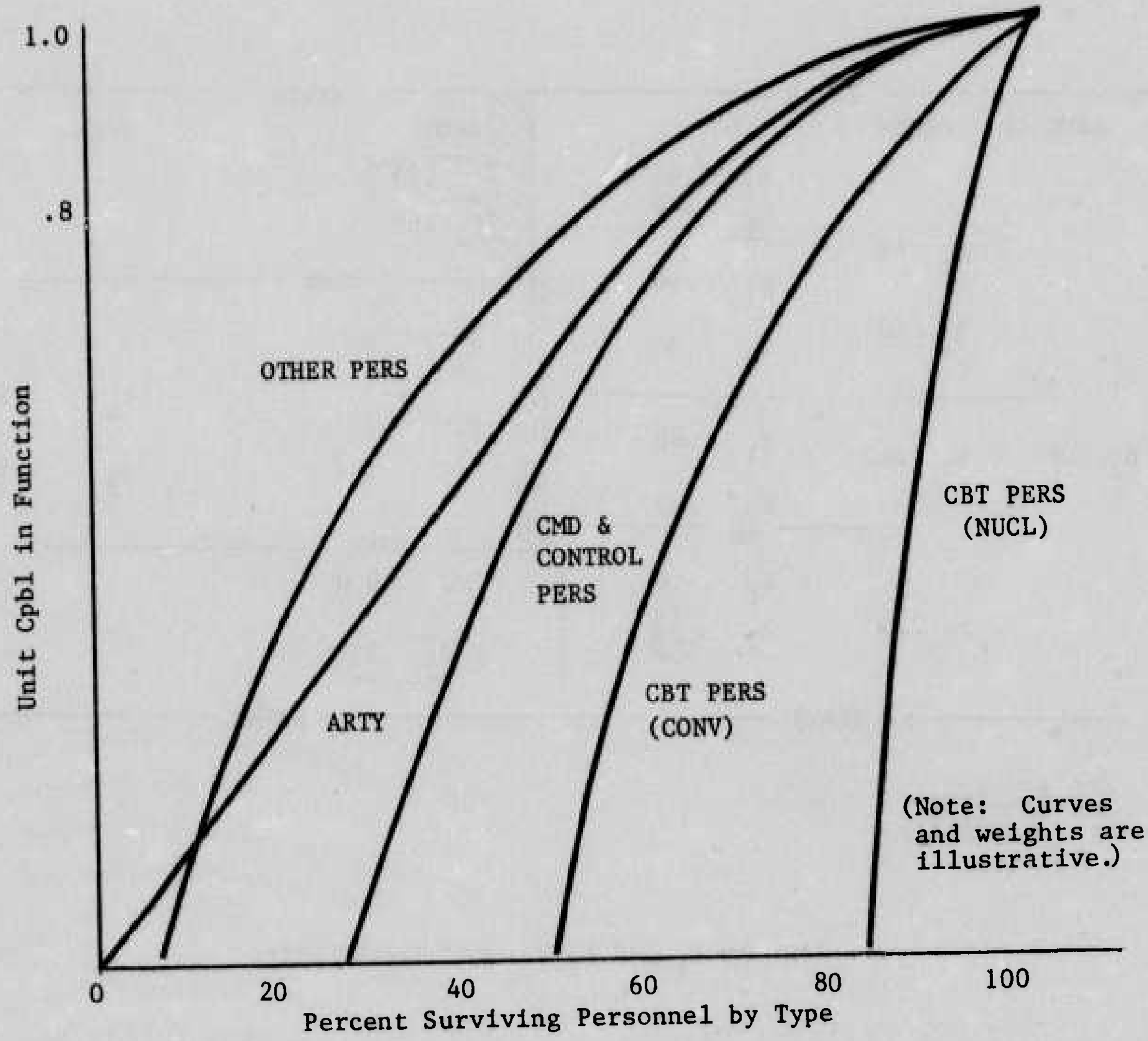


Fig. 10—CAPABILITY vs STRENGTH, BY FUNCTION

EQ 1 NATO Unit Cpbl $= \dfrac{1 \cdot \text{Cpbl}_{\text{OTHER}} + 20\ \text{Cpbl}_{\text{ARTY}} + 65\ \text{Cpbl}_{\text{CBT}} + 14\ \text{Cpbl}_{\text{CMD\&CONTROL}}}{100}$

EQ 2 PACT Unit Cpbl $= \dfrac{1 \cdot \text{Cpbl}_{\text{OTHER}} + 12\ \text{Cpbl}_{\text{ARTY}} + 77\ \text{Cpbl}_{\text{CBT}} + 10\ \text{Cpbl}_{\text{CMD\&CONTROL}}}{100}$

Ex $1A_{\text{(NUCLEAR)}}$ If NATO cas 10 % other, 40% arty, 19% cbt, 6% C^2, find unit cpbl.

Using Fig. 3 & EQ 1, Unit Cpbl $= \dfrac{1 \cdot (.98)+20(.76)+65(0)+14(.99)}{100} = .30$

Ex $1B_{\text{(CONV)}}$ With same casualties in conv war, find unit cpbl.

Using conv part Fig. 3 & EQ 1,

Unit Cpbl $= \dfrac{1 \cdot (.98)+20(.76)+65(.77)+14(.99)}{100} = .80$

Ex $2A_{\text{(NUCLEAR)}}$ If Pact casualties are as above, nuclear, find unit cpbl.

Using Fig. 3 and EQ 2,

Unit Cpbl $= \dfrac{1 \cdot (.98)+12(.76)+77(0)+10(.99)}{100} = .20$

Ex $2B_{\text{(CONV)}}$ PACT Unit Cpbl $= \dfrac{1 \cdot (.98)+12(.76)+77(.77)+10(.99)}{100} = .79$

Notice that <u>two</u> curves are used to relate unit capability to losses of combat personnel: a critical relationship for losses to nuclear weapons, and a less severe relationship for losses to conventional arms. This is believed appropriate in that nuclear weapons suddenly destroy or defeat entire platoons or companies suddenly, wreaking an amplified blow to the effectiveness of larger units, whereas conventional losses tend to be distributed over a longer time and greater area, and have a lesser impact on large unit effectiveness.

Conventional losses are estimated from a look-up table giving aggregate losses as a function of force ratio mission and terrain. The distribution among the four classes of personnel is constant. Nuclear losses are estimated by assuming one enemy nuclear package (see pp. 120, 121) delivered against the friendly unit on the narrowest ZOA or, if more than one unit is on the same ZOA which is less than the adaptive measure ZOA (see p. 54), a package against each. Losses are from table, p. 119.

The examples with Fig. 10 show a way of relating given personnel losses to residual unit capability. The curves relate unit capability to perform functions of one type to the percent surviving personnel of that type. The equations relate capability by function to aggregate unit capability. The weighting factors will be input by the user. The ones used in the example are consistent with NATO and Pact interest in and commitments to combat, arty, C^3, and other personnel.

Examples 1A and 1B illustrate the sensitivity of the outcomes to the divergent nuclear and conventional curves for combat personnel. Examples 2A and 2B, which use the same percent losses by type, illustrate the degree of sensitivity to the different personnel-type function weighting factors in Equations 1 and 2.

The goal "degrade the enemy's capability" is assessed for conventional options in a manner comparable to preservation of one's own capability. When nuclear options are considered, the package concept makes the estimation process easier. A nuclear package is defined in Chapter 9 as a set of nuclear weapons specified by number, type, yield, and delivery system sufficient to render ineffective a unit of specified

type and size (together with its normally colocated support) organized and engaged in a specific mission in a ZOA of X km when nuclear weapons effects are evaluated for specified defeat criteria, with a specific level of target acquisition on target elements. Thus if the i^{th} unit is using N packages in one option, the degraded effectiveness of the enemy facing the i^{th} unit is given by:

$$\text{FPDCR} = N\left[\frac{\text{STD ZOA}}{\text{ACTUAL ZOA}}\right]\left[\text{EN UNIT FP}\right]\left[\text{\% EN UNIT ON-LINE}\right]$$

where

FPDCR = unit firepower decremented

N = number of packages used

STD ZOA = km in package definition—i.e., km in which one unit would be made ineffective by 1 package

ACTUAL ZOA = total km to which N packages are to be delivered

EN UNIT FP = aggregate FP of enemy in ZOA being targeted

% ON-LINE = constant (user input) fraction of enemy assumed on-line for specified mission.

To keep the measure of performance E_4 positive and to have a value of 1.0 be perfect, E_4 is given by the equation $E_4 = 1 - \frac{\text{enemy capability at EOP*}}{\text{enemy capability at BOP**}}$.

The final goal in combat, "minimize collateral damage," is measured by comparing civilian casualties with the number stated as tolerable by the user. E_5 should have a value of 1.0 when no civilian casualties occur and be 0.0 when the tolerable limit has been reached. Thus MINTSIM defines E_5 by the expression

$$E_5 = 1 - \frac{\text{actual civilian casualties}}{\text{tolerable civilian casualties}} .$$

The techniques for calculation of the E's will be given in Chapter 11, with expansion of the nuclear assessment techniques in Chapter 9.

* EOP = end of period.

** BOP = beginning of period.

After choosing the goals in combat and assuring himself that acceptable measures of performance, E's, are at hand for each, the user must ascribe relative weights to the goals. Since a commander is rarely able to achieve all of his goals simultaneously, he must decide what goals to emphasize and what goals to de-emphasize. This will depend on his mission. For example, in a position defense, holding ground is more important than conserving strength. In a delay, however, conserving strength is more important than holding ground. The idea is shown in Fig. 11.

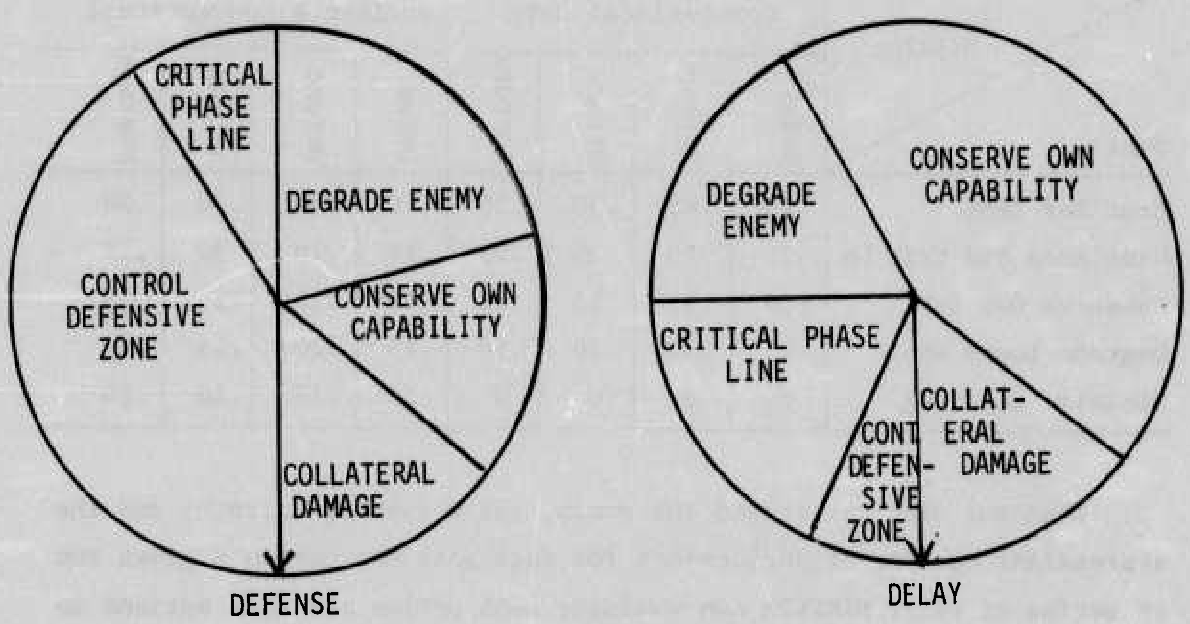


Fig. 11—Value of A's for Defense and Delay

On the left, for the defense mission, great emphasis is given to holding ground and relatively small emphasis to conserving one's own capability. For the delay mission, on the right, the emphasis is reversed. There is great emphasis on conserving one's own capability and relatively little emphasis on holding ground within our defensive position. The other weights do not change very much.

Now, how does one put numbers to the emphasis? The pie chart makes this clear. The user inputs the percent importance he attaches to each performance measure or goal for each mission: rupture, attack or counterattack, defense, and delay. This is the percent importance and all of them must add up to 100.

Illustrative sets of A's for both NATO and the Pact might be as given in Table 3.

Table 3

WEIGHTING FACTORS, A's, FOR GOALS IN COMBAT

Goal \ Mission	Conventional Only				Nuclear & Conventional			
	Delay	Defend	Attack	Rupture	Delay	Defend	Attack	Rupture
Cont Def Zone	.10	.45	.30	.55	.10	.40	.30	.50
Cont Area Fwd Crit Ln	.25	.10	.35	.25	.15	.10	.30	.25
Conserve Own Cpbl	.50	.15	.15	.10	.45	.15	.15	.05
Degrade Enemy Cpbl	.15	.30	.20	.10	.15	.20	.15	.10
Minimize Coll Dmg	0	0	0	0	.15	.15	.10	.10

When the user has stated the goals, the weighting factors, and the appropriate measure of performance for each goal for use in a given run or series of runs, MINTSIM can evaluate each option and rank options in order of attractiveness. This process will be presented in the next section.

Once the list of options to be examined has been generated, the assessment routine of the ground model is applied, using the estimated data of the MMS model, not "truth." For options with values of E_1 and E_2 estimated at 0, the option is not further estimated and is discarded as not suitable. If all options are so discarded, then evaluation of the remaining E's is accomplished and a preferred option chosen as described for the normal case.

Values of E's are estimated for each option, multiplied by the corresponding A value input by the user for the unit mission and summed. The option which achieves the greatest sum is selected as the preferred option. Subordinate units are then allocated nuclear packages and CAS/FS and assigned reserve units, ZOAs and missions (by designating A's) for the next period as indicated in the chosen option.

The MMS submodel performs the routine for each command echelon on each side, starting at theater level each time. Sequencing of sides is arbitrary; Blue is considered first.

Chapter 5

ADAPTIVE MEASURES

INTRODUCTION

Adaptive measures are decisions to enhance survivability from nuclear attack at the expense of conventional effectiveness, or decisions to maintain or improve conventional effectiveness at the expense of survivability from nuclear attack.

Adaptive measures reflect the impact of nuclear risk on a conventional battle. The risk will exist in any war between nuclear powers. Adaptive measures will affect the conduct of a conventional battle prior to the use of nuclear weapons, a conventional battle after the use of nuclear weapons, and a conventional battle during a nuclear war where nuclear weapons are not used.

There are many adaptive measures that might be employed. The criterion for selecting those to be included in MINTSIM is that there must be an explicit and measurable penalty associated with the adaptive measure. If there is no penalty, then the forces should adopt the measure all the time.

There are two classes of adaptive measures: (1) those that apply to the theater as a whole on each side; and (2) those that apply only to one or more sectors. The theater commander orders theater-wide adaptive measures based on his assessment of the risk of nuclear attack. The only adaptive measure that can vary is the deployment of on-line forces. The theater commander specifies the minimum zone of action (sector) of on-line divisions for each NATO corps and of on-line armies for each Pact front to be used in the MMS model.

To simplify the system, only two states of nuclear risk can exist: high or low. The method for assessing the risk is described in Chapter 7.

THEATER-WIDE ADAPTIVE MEASURES

The following adaptive measures are adopted or not adopted according to the theater commander's risk assessment:

	High	Low
- Dispersal of aircraft to primitive air bases	x	
- Dispersal of logistic units and facilities	x	
- Withdrawal of nuclear-capable aircraft		x
- Withhold of dual-capable aircraft		x
- Conventional attack of acquired enemy nuclear delivery systems in conventional war	—	—

Aircraft Dispersal

Dispersal of aircraft to primitive air bases reduces the sortie rate as described in Chapter 8, but dilutes the air base target system presented to the enemy.

Withdrawal of Nuclear-Capable Aircraft

Withdrawal of nuclear-capable aircraft eliminates their risk to enemy attack as they are assumed to be withdrawn to unspecified sanctuary on both sides. The user specifies the number of withdrawn aircraft and the fraction that have a unique signature (e.g., F-111's). Other withdrawn aircraft are indistinguishable from aircraft participating in the ongoing conventional battle. If and when unique withdrawn aircraft are returned, they become an input to the enemy's risk assessment, described in Chapter 7.

The user may specify (for either or both sides) that withdrawn aircraft participate in the ongoing battle, but only for interdiction/deep air support missions. These aircraft are then subject to enroute attrition. Their sortie rate is degraded to account for the additional distance flown, the added load on communications, and coordination problems with in-theater air and ground forces. The user inputs the nuclear and conventional sortie rate.

Withhold of Dual-Capable Aircraft

A user-specified fraction of aircraft, whose pilots are trained for both nuclear and conventional attack, may be withheld from use but not withdrawn from the theater. They are assumed to be in shelters on developed air bases as long as the nuclear risk is low. They are assumed to have nuclear weapons on board.

Conventional Attack of Nuclear Targets in Conventional War

Depending on the implied political constraint, the user has two possible options for this adaptive measure.

1. Conventional attack on acquired enemy nuclear systems (other than airfields) is top priority as long as the nuclear risk is low. No attack allowed when the risk is high unless nuclear weapons are used and the political constraint allows them to be attacked.

2. Conventional attack on acquired enemy nuclear systems (other than airfields) is not allowed until the nuclear risk is high. If political constraints prevent a nuclear attack on enemy nuclear systems, a conventional attack will be made as first priority.

The user may choose, if desired, a different option for each side.

MINIMUM ZONE OF ACTION (SECTOR)

The user specifies four zones of action, two for NATO, and two for the Pact. One represents a doctrinal minimum; the other represents a higher minimum to increase survivability in the event of a nuclear attack.

ZOA (Sector)	NATO	Pact
Doctrinal Minimum (km)	____	____
Adaptive Minimum	____	____

Regardless of the theater commander's assessment of risk and his prescribed minimum ZOA, there is an absolute requirement that when a NATO Corps or Pact Front commander examines a nuclear option against on-line enemy forces, his own on-line forces must be on at least the adaptive minimum. All other adaptive minima depend on the assessment of risk of enemy attack versus the conventional penalty for being dispersed.

When the theater commmander assesses a high risk of nuclear employment and orders theater-wide adaptive measures, he also examines each Corps or Front to determine whether or not to order an adaptive minimum or to remain on the doctrinal minimum. The following rules apply to both NATO and Pact theater commanders:

- The doctrinal minimum remains in effect whenever

  1. A rupture has or is predicted to take place in a sector, or
  2. The distance to the final defense line in a sector is less than the trigger value described in Chapter 9.

- In all other sectors, the adaptive minimum is prescribed.

If the doctrinal minimum is allowed, it is overridden in the MMS procedure, when nuclear options are examined in the sector(s) of concern. If a nuclear option is selected, the adaptive minimum is put into effect in the applicable sector(s).

When the actual zone of action or sector is close to but less than the adaptive miminum, it is suggested that a 10-15 percent factor be inserted in the model to avoid unrealistic oscillations. For example, if the adaptive ZOA is 25 km and the actual ZOA is at least 22, and no nuclear option is considered in that sector, it is not necessary to move an entire division into reserve or readjust corps/front boundaries to produce the required ZOA.

Chapter 6

COMMAND, CONTROL, AND COMMUNICATIONS (C^3)

GENERAL

MINTSIM does not have an explicit C^3 submodel. In MINTSIM, C^3 plays an important part in all decisions and affects most assessments through a mechanism called the C^3 index. Each Corps, Army Group/ Front, and theater headquarters in MINTSIM has a C^3 index, as do those of all NATO divisions and Pact armies. The initial C^3 index for each headquarters is a number between 0 and 1 on a comparative basis with all headquarters at the same echelon. The initial index is affected by the percent of C^3 personnel in the headquarters (including normally supporting elements such as a Sig Bn), by the percent of cost of the C^3 equipment to all equipment, and by the number of alternate headquarters manned. *

After the C^3 index is assigned, it is subject to change as type C personnel are lost or gained by the headquarters, and as the number of alternate headquarters changes. Alternate headquarters are destroyed only during nuclear war, whereas type C personnel may become casualties at any time. Replacement personnel of type C will increase the C^3

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* Without question, determination of the C^3 index is critical since MINTSIM causes the index to affect many areas of the decision and operations processes. Choosing the best measures for generating and modifying the index must come after experimentation with and assessment of candidate measures. In addition to the percent of total equipment cost, it appears desirable also to compare C^3 equipment on its fulfillment of weighted characteristics such as capacity, security, and mobility.

index, as will reconstituted headquarters. Destroyed headquarters may be reconstituted following an input delay provided sufficient type C replacements have become available. The C^3 index can never exceed its initial value during a run.

To the extent that the C^3 index is less than 1, it affects other portions of MINTSIM as follows: degrades combat effectiveness (by degrading potentially available combat power); increases delay time for committing reserves; lowers the accuracy of the input information available on both enemy and own forces to the commander in the MMS process; degrades effectiveness of the target acquisition process; lowers effectiveness of nuclear weapons (assumed to be through both timing and delivery error); lowers effectiveness of SAM defenses; lowers effectiveness of air support (affected only by theater C^3 index); and decreases amount of resupply and number of replacements arriving in theater (as shrinkage).

GENERATING THE C^3 INDEX

Headquarters and units are compared with like elements. Thus all NATO Corps are compared with each other; Army Groups are compared with themselves and with Pact Fronts. NATO divisions are compared among themselves; Pact armies, the smallest Pact maneuver units represented, are compared among themselves. In each category the structure of each headquarters is examined to determine, at full strength, the percent of people in a primary C^3 job (including normal support such as a signal unit), and the percent of total equipment cost represented by C^3 equipment. The doctrine and tactics of the unit are examined to determine the number of alternate headquarters which are normally manned and equipped. The percent of C^3 people (C^3 cost) (number of alternate headquarters) for each unit is divided by the maximum percent or number

found among all units in the category. These three quotients are then combined, with equal weighting, to give the C^3 index of the unit.

$$C_{i_{raw}} = \frac{1}{3}\frac{PCP_i}{PCP_{max}} + \frac{1}{3}\frac{PCC_i}{PCC_{max}} + \frac{1}{3}\frac{AH_i}{AH_{max}}$$

where

$C_{i_{raw}}$ = raw C^3 Index of i^{th} unit.

PCP_i = percent type C personnel in i^{th} unit headquarters.

PCP_{max} = maximum percent type C personnel in any unit headquarters.

PCC_i = percent C^3 equipment cost in i^{th} unit headquarters.

PCC_{max} = maximum percent C^3 equipment cost in any unit headquarters.

AH_i = number alternate headquarters in i^{th} unit.

AH_{max} = maximum number alternate headquarters in any unit.

For example, a Belgian division headquarters might have 13 percent type C personnel, 4 percent C^3 equipment cost, and maintain 3 alternate headquarters, while an FRG division might have 8 percent type C personnel, 9 percent C^3 equipment cost, and maintain 4 headquarters. If there were only these two divisions in the category, the Belgian division C^3 index would be

$$C_{B_{raw}} = \frac{1}{3}(\frac{13}{13}) + \frac{1}{3}(\frac{4}{9}) + \frac{1}{3}(\frac{3}{4}) = .73$$

and the German,

$$C_{G_{raw}} = \frac{1}{3}(\frac{8}{13}) + \frac{1}{3}(\frac{9}{9}) + \frac{1}{3}(\frac{4}{4}) = .87 .$$

After the relative raw indices are determined, they are then normalized within each category (corps, etc.) to give the highest raw index a value of 1.0. The normalized indices are called the initial C^3 indices and are represented by C_{i_o}. For example, $C_{G_o} = 1.0$, $C_{B_o} = .84$.

C^3 INDEX CHANGES DURING THE SIMULATION

The index changes as the number of type C personnel and the number of alternate headquarters change. Variations in C^3 equipment status are not stored in MINTSIM, hence do not directly affect the index. An electromagnetic pulse (EMP) effect of certain types of nuclear bursts would be considered to render one or more alternate headquarters ineffective and hence change the index, regardless of casualties. Studies now in progress at Harry Diamond Laboratories should clarify the extent and effect of EMP.

Type C personnel can be lost during conventional or nuclear war. They constitute a fixed fraction of normal replacements and will be assigned to the units which are low on type C personnel. Headquarters at corps and above are a separate target category in MINTSIM. They can be attacked with conventional or nuclear weapons. Conventional attack causes loss of type C personnel, whereas nuclear attack may also destroy one or more of the alternate headquarters. Degradation of the C^3 index through loss of type C personnel is shown in Fig. 12.

The current C^3 index, C_i, is given by

$$C_i = C_{i_o}(\text{fraction of } C_{i_o} \text{ remaining}).$$

Loss of an alternate headquarters has a turbulent effect on unit C^3, but becomes devastating only when there is only one headquarters left. To represent this turbulence and increasing effect, the loss of N headquarters is represented by some function, e.g.,

$$C_i = C_{i_o}\left[1 - \left(\frac{N}{\text{original \# HQ}}\right)^X\right]$$

The following table shows the remaining fraction of C_{i_o}.

Table 4

DEGRADATION OF C^3 INDEX AS ALTERNATE HQS ARE DESTROYED

No. HQ Originally	No. HQ Lost			
	1	2	3	4
2	.xxx	0	–	–
3	.xxx	.xxx	0	–
4	.xxx	.xxx	.xxx	0
5	.xxx	.xxx	.xxx	.xxx

When only one headquarters remains, the degradation from loss of headquarters (Table 4) and from loss of type C personnel within that headquarters (Fig. 12) are combined by multiplication to find the C^3 index of the unit.

The user can also specify a particular degradation of C_{i_o} to occur whenever a particular event occurs.* For example, the user might elect to degrade C_i by the factors and for the periods shown in Table 5.

Table 5

SPECIFIED EVENTS DEGRADING C^3 INDEX

Factor to be Applied to C_i**	Trigger	Duration
—	1st use of enemy nucs in sector	succeeding period
—	1st entry of unit/command on-line	next N periods
—	successful rupture of own defensive zone	succeeding period
—	1st use of own nucs in sector	succeeding period
—	application of C^3 adaptive measure	continuous
—	submit attached to unit of different nationality	continuous

* One of the critical events which may well occur and which could have a devastating effect on C^3 and the C^3 index is an electronic warfare (EW) attack. At present, MINTSIM does not provide a commander the option of applying EW resources against the enemy. When the necessary studies on the combat effectiveness have been completed, it may be possible to modify MINTSIM to keep track of EW resources, to permit commanders to apply them, and to degrade the C^3 index.

** These factors multiply the C^3 index in effect after the event occurs.

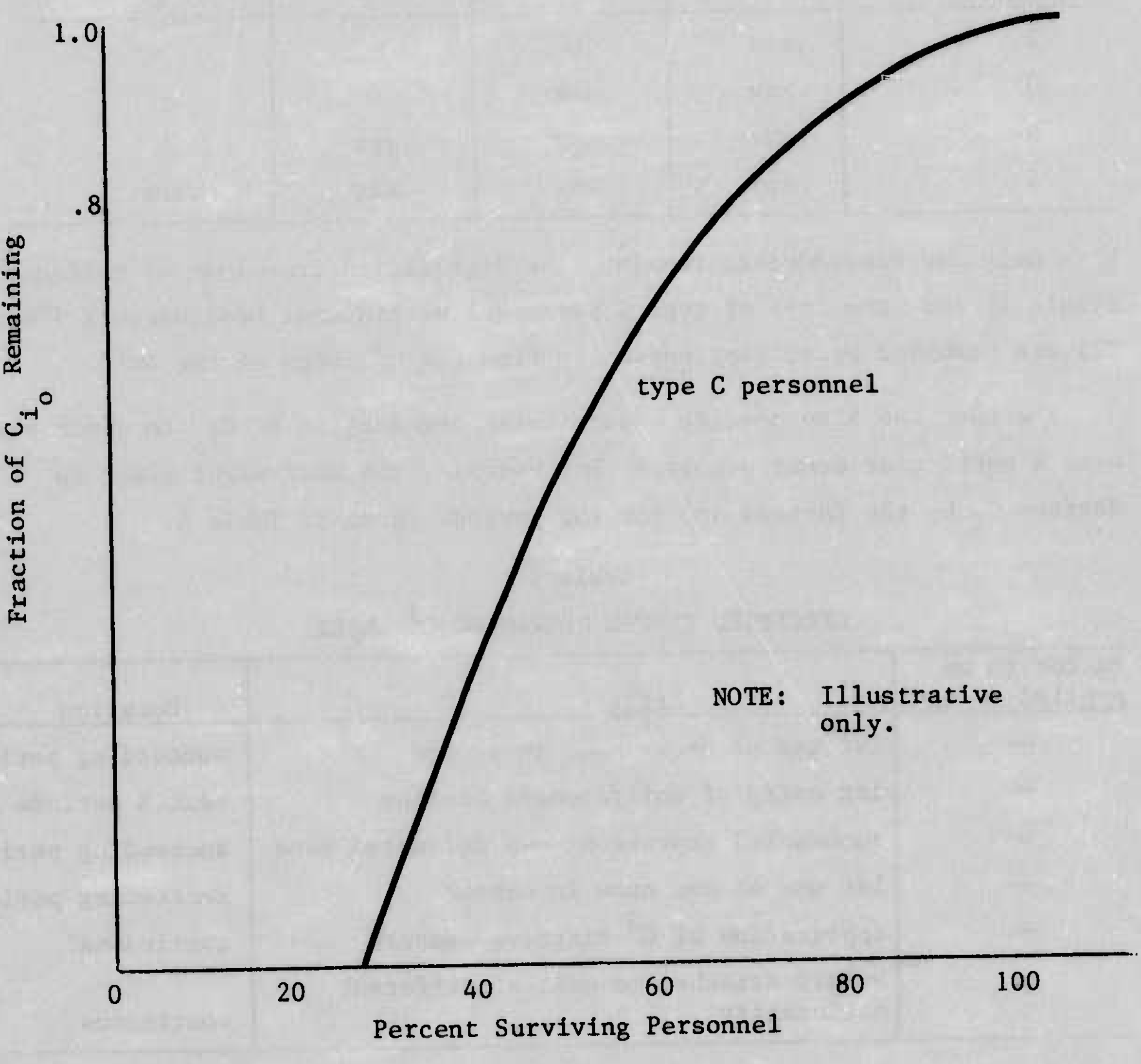

Fig. 12—C^3 Capability as a Function of Type C Personnel

APPLYING THE C^3 INDEX

The ability of a headquarters to exercise effective C^3 has an impact not only on itself, but upon subordinate units and higher headquarters. Simulation of these impacts is represented in MINTSIM in a number of ways, always using the C^3 index, C_i, and sometimes the initial C^3 index, C_{i_o}.

CAS and the combat effectiveness of a unit such as a division are not only directly affected by the division C_i, but by the degree to which higher echelon headquarters (HEH) perform. If the HEHs do not complete effective plans and issue timely orders, the effectiveness of available CAS and the combat power of subordinate units will be degraded. MINTSIM represents the effects of the unit C^3 by multiplying the relative firepower (FP) or CAS by the unit C^3 index, C_i. The effect of HEHs is represented by the ratio that the current HEH C_i bears to its $C_{i_{max}}$. Thus a NATO division with an aggregate FP and CAS of 20, a C_i of .9 under a Corps with a C_i = .91, $C_{i_{max}}$ = .95, and with Army Group and Theater having $C_i = C_{i_{max}}$ would have a combat effectiveness (CE) for its FP and CAS given by

$$CE = 20(.9)\left(\frac{.91}{.95}\right)(1)(1) = 17.24.$$

Commitment of reserves is affected by poor C^3 in real life in the form of faulty or late decisions which may be poorly communicated or improperly coordinated. The question of faulty decision is deferred for the moment; late decisions result in tardy arrival of the unit. In MINTSIM, reserve units can always arrive on-line within the look-ahead period of the commander. Late arrival within the period is simulated by artifically degrading the unit combat power and assuming that the unit is available throughout the period.

As Chapter 10 will show, it takes a division in theater reserve 2 days to be available to an on-line corps. The theater look-ahead period is 4 days. With perfect C^3 at theater level, the useful FP of the division would be $\frac{2(FP)}{4}$ during this 4-day period in theater estimates. If the theater C^3 index were less than perfect, the division combat effectiveness during the period would be degraded by the judgmental factor, $\sqrt{C_{i_{THEATER}}}$.

$$\text{Thus, } CE = \sqrt{C_{i_{THEATER}}} \cdot \frac{2FP}{4}.$$

Target acquisition is affected in real life by poor C^3 in degraded task assignment, late orders, erroneous or late transmission of information, poor collation of available information, faulty assessments on available intelligence, and erroneous transmission of target data. Enemy deceptive measures have a greater probability of success. These effects are introduced into the MINTSIM target acquisition system after it has operated normally, as described in Chapter 7.

SAM effectiveness, air operations other than CAS, and conventional missile attacks are degraded alike. The effectiveness of each is degraded by the square root of the appropriate C^3 index. This is the theater index for degrading SAMs and conventional air operations other than CAS; the index of the controlling headquarters for conventional missile attacks, e.g., corps headquarters for LANCE attacks.

The effects of nuclear weapons are degraded more sharply (the targets being usually more time-sensitive) than for conventional weapons. (Nuclear packages are used against target classes 5 and 6 where degrading degree of knowledge adequately reflects the degrading effect of poor C^3.) Nuclear effects of packages are degraded directly by the index, C_i, when the number of component elements of a target is to be reduced as, for example, surviving personnel or remaining tons of supply. When the type target is destroyed by a nuclear weapon, the number of targets successfully hit will be reduced to the integral number closest to $C_i \cdot$ (targets attacked).

Replacements and resupply represent a challenge to poor C^3. Improper C^3 will maldistribute personnel and supplies and cause them to arrive late or not at all. In MINTSIM these effects are represented by shrinkage. During any period the number of replacements and tons of supply actually available for distribution are reduced by the factor $\sqrt{C_i}$ at each echelon. Personnel and supplies not usable in one period because of this shrinkage are added to arrivals available for distribution in the succeeding period (to which the then-current $\sqrt{C_i}$ will be applied).

The impact of C^3 in the MINTSIM model is summarized in Table 6.

Table 6

SUMMARY OF C^3 INDEX EFFECTS

Process Affected	Manner of Representing C^3 Effect
CAS and Unit Combat Effectiveness	Effectiveness = FP(unit C_i)$\left(\frac{\text{each HE } C_i}{\text{HE } C_{i_{max}}}\right)$
Reserve Commitment	Reserve effectiveness = normal effectiveness$\cdot\sqrt{C_{i_{\text{HQ Using Res}}}}$
Target Acquisition	Misidentifications increased by factor $\frac{1}{C_i}$ POK multiplied by factor C_i/C_{std}
SAM effectiveness Air operations other than CAS Conv. missile fires	Degraded by $\sqrt{C_i}$ theater
Nuclear weapon effects (NON-PACKAGES)	Elements defeated or targets destroyed multiplied by C_i of commander controlling delivery system.
Replacements, resupply	Amount available reduced by factor $\sqrt{C_i}$. Shrinkage not lost to system; reappears next period.

NOTE: Since quantitative studies of the impact of C^3 on the combat effectiveness of units are lacking, there is considerable uncertainty about the functional form of the C^3 index for various applications. The

MINTSIM programmer, therefore, should develop the capability for any functional form of C^3 to be applied: linear, concave, convex, or S-shaped. The simplest, fastest, and most general capability is to interpolate among five points provided by the user from the results of future studies.

Until such studies have been made, the functional forms of Table 6 are suggested for the C^3 index.

Chapter 7

INTELLIGENCE AND TARGET ACQUISITION

INTRODUCTION

The intelligence and target acquisition model provides inputs to the MMS, air, nuclear, and ground combat models. It receives input from the unit status files, C^3, and MMS model.

The intelligence submodel assesses the likelihood that the enemy will use nuclear weapons and degrades the decision-maker's knowledge of enemy capabilities.

The target acquisition submodel produces a list of targets believed acquired (other than enemy divisional forces) for conventional or nuclear attack by aircraft and missiles, and produces a target acquisition index for nuclear attack on enemy on-line and off-line divisions.

INTELLIGENCE SUBMODEL

General

The intelligence submodel is used only for selecting a course of action by the decision-makers on both sides. Only the theater commander assesses the risk of enemy use of nuclear weapons and the effects of his own strikes on rear-area targets in past periods. Enemy ground capabilities, however, are estimated by all decision-makers.

Risk of Enemy Nuclear Use

The theater commander assesses the risk that the enemy will use nuclear weapons in each decision cycle. The risk may be high or low. If the risk is high, the theater commander orders adaptive measures, as

described in Chapter 5. If the risk is low, he does not order adaptive measures or countermands previously ordered adaptive measures. If the enemy has used nuclear weapons in the previous cycle, the risk is high.

The perceived risk of enemy use is defined as the sum of values assigned by the user to a number of factors. Those factors indicating imminent enemy use are assigned positive values; those factors indicating no enemy use are assigned negative values. If the sum of all values is greater than zero, there is a high risk of enemy use; otherwise, there is a low risk of enemy use.

A suggested list of factors is given below with their associated values, which should be different for each theater commander:

Factor	Positive Value	Negative Value
Own side selects nuclear option	99	
Own side took adaptive measures last decision	99	
Enemy used nuclear weapons in last 24 hours	99	
Enemy took adaptive measures in last 24 hours	99	
Enemy took adaptive measures earlier but did not use nuclear weapons		x
Enemy used nuclear weapons earlier but not in last 24 hrs.		x
Enemy used nuclear weapons earlier but not in last 48+ hrs.		x+
Enemy did not take adaptive measures		x+
Enemy cancelled adaptive measures previously in effect		x+
Enemy winning air battle		x
Enemy losing air battle	x	
Enemy drawing air battle	0	0
Enemy ruptured own forces		x+
Own side ruptured enemy force	x	
Enemy advance but no rupture		x
Own side advance but no rupture	x	
Average FEBA moved less than _____ last period	x	
Enemy E_2 moved less than ___ after ____ days	x+	
Enemy retreat	x	

The value "99" forces adaptive measures to be selected. The purpose of "99" when adaptive measures were selected in the previous decision cycle is to prevent unrealistic oscillations in adaptive measures from period to

period. The value "x+" indicates that a higher numerical value should be chosen than "x."

The ground and air battle indicators are perceived rather than actual values, as described in the following section. If the C^3 index exceeds the thresholds given on page 71, then a one or two cycle delay is imposed between actual and perceived enemy adaptive measures.

Enemy Capabilities

The commander at each echelon estimates the enemy capabilities that can be brought to bear on his forces in the estimation period. The data base for this estimate is the true capability and location of enemy forces. The true data are modified to reflect the degree of accuracy and completeness that the estimating commander would have in a given situation. Three factors are used to modify the true enemy capability:

1. The estimated enemy mission.
2. The enemy capability in the previous period as derived from the FEBA movement in the estimating commander's sector.
3. The perceived capability of enemy reserve (second echelon) forces to reinforce on-line forces in the estimating commander's sector.

Enemy Mission. The perceived mission of the opposing enemy may be estimated as (1) the actual enemy mission in the previous period, (2) opposite to the estimating commander's mission, e.g., defense vs attack or rupture, or (3) the most aggressive mission that the perceived force ratio permits. Whichever criterion is chosen by the user applies throughout the campaign.

Enemy Capability in the Previous Period. The estimate of the enemy's capability in the previous period is based on the perceived FEBA movement in the estimating commander's sector and his own force effectiveness. The FEBA movement is the average over the estimating commander's sector, derived as follows:

$$\text{Perceived FEBA movement} = \frac{(\text{FEBA}_n - \text{FEBA}_{n-1})_{\text{true}}}{\text{C3I}}$$

where C3I is the C^3 index of the unit among his immediate subordinate echelons that gained (lost) the most ground in the preceding period. This equation will make attackers bold in proportion to their past success and defenders cautious in proportion to their past failure. The degree of boldness and caution will depend on the commander's knowledge of the situation as represented by the C^3 index.

The programmer, if desired, may provide means for the user to specify other attributes to the commanders (which may differ for each side), remembering that these attributes apply throughout the campaign simulated in MINTSIM. There are four possibilities in all:

1. Commanders are bold all the time, i.e., underestimate their enemy. This attribute requires the FEBA movement to be divided by the C^3 index when the commander has advanced and multiplied by the C^3 index when he is pushed back.
2. Commanders are cautious all the time, i.e., overestimate their enemy. This requires the FEBA movement to be multiplied by the C^3 index when the commander has advanced, and divided by the C^3 index when he is pushed back.
3. Commanders are bold in proportion to their previous success and cautious in proportion to their previous failure. This requires the FEBA movement to be divided by the C^3 index regardless of the direction of movement.
4. Commanders are cautious in proportion to their previous success and bold in proportion to their previous failure. This requires the FEBA movement to be multiplied by the C^3 index regardless of the direction of movement.

Friendly force capabilities are estimated in a similar manner. For each immediate subordinate echelon:

$$\text{Perceived effectiveness} = \text{true effectiveness in last period} + \frac{\text{Eff}_n - \text{Eff}_{n-1}}{\text{C3I}}$$

where a corps or front commander's perception of his effectiveness is the sum of the perceived effectiveness of each of his subordinate divisions or armies.

Using the FEBA movement table as a function of force ratio, mission, terrain, etc., in reverse, the commander determines the total enemy force that was used against him in the last period.

Enemy Reserves (Second Echelon Forces)

The theater commander estimates the number of off-line (NATO) divisions (Pact armies) by subtracting the perceived on-line forces in the last period from the total forces in the enemy theater order of battle. The perceived D-day order of battle is a user-defined multiple (greater or less than 1.0) of the actual order of battle for each side, depending on the following factors:

- Number of days of mobilization and alert prior to hostilities.
- National and regional intelligence capabilities on each side.

After D-day, additions to the order of battle will become known to the theater commander with a delay that depends on his C^3 index. No delay implies that the estimating commander knows about the newly arrived force on the day it is available for commitment and, therefore, is first considered by the opposing commander. The user inputs a threshold C^3 index for the delay in acquiring this information:

C^3 Index	Delay
________	No delay
________	1 day delay
________	2 days delay.

Army Group/Front. The army group/front commander is concerned only with enemy forces that can affect his operations in his forecast period for his estimate of the situation. He explicitly estimates the reserves (second echelon) forces that can be committed against his forces in his forecast period. The estimate is based on the true forces with a delay

that depends on his C^3 index with the same format (but not the same numbers) as the theater commander's estimate. The sum of the estimates for all army group commanders need not match the theater commander's total because subordinate commanders are allowed to consider worst case situations.

Corps/Army. The same system is used for corps/army commanders, except that only NATO army group reserves and second echelon armies of first echelon fronts are included. In this case, there is an override from the target acquisition model. If major subordinate elements (e.g., Pact armies) are acquired, there is no delay in adding them to the known second echelons.

TARGET ACQUISITION SUBMODEL

Target Classes

There are eight target classes:

I. Medium-range missile batteries or launchers (PERSHING, SCALEBOARD, etc.)

II. Short-range missile batteries or launchers (LANCE, PLUTON, SCUD)

III. Airfields and SAMs

IV. Nuclear custodial units, not colocated with delivery units

V. On-line division forces, including non-divisional artillery and organic nuclear systems (HONEST JOHN, FROG)

VI. Off-line division forces

VII. Corps (army, army group (front) headquarters

VIII. Theater supply pool.

The details of these target classes, means of acquisition, and means of attack are shown in Fig. 13.

TARGET CLASS	COMPONENTS	CHARACTERISTICS	LOCATION	ACQUIRED BY	ATTACKED BY	EFFECT OF DESTRUCTION
I	Batteries*(PERSHING, SCALEBOARD) Missiles* Launchers* Nuclear Weapons* Personnel* Supplies		Beyond Class II range	Tac Air SIGINT Satellite	Tac Air Class I	All components reduced by nuclear and conventional attack.
II	Batteries*(LANCE, PLUTON, SERGEANT, SCUD) Missiles* Launchers* Nuclear Weapons* Personnel* Supplies		Beyond Class V weapon range in corps area	Same as I	1. Class II 2. Tac Air or or Class 1	All components reduced by nuclear and conventional attack.
III	Airfields Shelters Aircraft* Nuclear weapons* SAMs Supplies	Primitive, developed NOTE: Tac Air sortie rate limited by (a) input maximum, (b) airfield capacity (SC), or (c) supply status.	Forward, rear	Same as I	Tac Air Class I Division over-run	1. Nuclear attack destroys aircraft & shelters, & reduces other components, which are spread over surviving airfields. 2. Same for overrun. 3. Conventional attack reduces all components, including sortie capacity (SC) (effects spread over all airfields). NOTE: New airfields & SC are added at constant rates.
IV	Depots Nuclear weapons*		Beyond Class II range	Same as I	Tac Air Class I	1. Nuclear attack destroys depots & reduces nuclear stocks (spread over survivors). 2. Conventional attack reduces nuclear stocks only.
V	A. Divisions (Pact Armies) Personnel* Nuclear weapons* Nuclear delvy. means* Supplies B. Non-divisional Artillery* (tubes,HJ,FROG) Personnel* Nuclear weapons* Tubes, lchrs.* Supplies C. SASP Slice Nuclear weapons*		On-line division area	Tac Air HQs Divisions	SRMs Divisions	1. Nuclear or conventional attack reduces all components. 2. SASPs are re-sliced each period, depending on the number of on-line divisions. 3. Non-divisional artillery is lumped & reallocated ea. period. Conventional effectiveness is limited by available tubes, personnel, or supplies.
VI	Divisions (Pact Armies) Personnel* Nuclear Weapons* Nuclear delvy. means* Supplies		Theater & Front reserves beyond Class II & V wpn range; AC & corps reserves beyond Class V weapon range. In parent unit sector.	Same as I	Same as II (See note on location)	All components reduced by any attack.
VII	HEHs Personnel*	1. At least 1 HQ in ea echelon above division. 2. Each echelon has a C^3 Index.	As above, with "HQ" in place of "reserves." In unit sector.	Same as I	Same as II (See note on location)	1. Nuclear attack destroys HQ & reduces personnel in echelon. 2. Conventional attack reduces personnel in echelon. 3. C^3 Index is degraded, depending on % of orig. personnel remaining in echelon.
VIII	Depots Supply tons		Same as IV	Same as I	Same as IV	Same as IV.

* By type.

Fig. 13—Details on Target Classes

The Target List

The theater commander on each side is the only decision-maker who is involved in the attack of off-line forces. Target lists are recreated each period. The number of targets acquired in each class is a function of all sensors. But, to simplify the model, the capability of all sensors (national assets, theater assets, reconnaissance aircraft, and capabilities of subordinate echelons) are combined to provide the number of targets in each class that are believed acquired.

A percent of knowledge table is used to define the fraction of targets present in each class that would be acquired if the C^3 index were a particular value, a standard number of reconnaissance sorties were successful, and there were no dummy targets, no unrecognized movement, and no misidentifications.

False Targets. There are three ways in which non-targets can be added to the target list:

- Physical or electronic dummy targets in each class created by the enemy.
- Targets that are misidentified by observers, photointerpreters, SIGINT, and radar analysts.
- Targets that moved since last observation and are believed to be in the same location.

Dummy Targets. The user inputs the fraction of targets in each class that are dummies on each side. Particular attention should be given to dummy nuclear delivery systems and higher-echelon headquarters.

Misidentified Targets. In reality, there are two classes of misidentifications: high priority targets (e.g., medium range missiles) that are identified as trucks or tanks; and trucks, etc., that are

identified as high-priority targets. Only the latter class creates false targets for rear area attack. The user inputs the multiplier applied to the true number of priority targets to account for this type of false target.

Unrecognized Movement. Movement of real target between last observation and strike makes a strike ineffective, but does not affect the target list. A false target is added to the target list, however, if a previously acquired target moves but is not deleted from the new target list. On the other hand, if a previously acquired target does not move and is not reacquired at the same location, a viable target might be deleted from the list. The user inputs a policy for each side, which may differ for conventional and nuclear attack, stating how long a non-reacquired target in each class remains on the target list.

Target Class	Number of Days on List			
	Pact Policy		NATO Policy	
	Nuclear	Conv.	Nuclear	Conv.
Medium range missile	____	____	____	____
Short range missile	____	____	____	____
Primitive air bases	____	____	____	____
Nuclear depots	____	____	____	____
Higher echelon Hqs	____	____	____	____

The user inputs a similar table giving the movement policy for these target classes, i.e., the fraction in each decision cycle that move far enough that an attack on the previous location will produce no damage. Primitive air bases are included because both sides can play a shell game with airstrips and stretches of autobahn.

Target Class	Fraction Moved Per Day			
	Pact Policy		NATO Policy	
	Nuclear	Conv.	Nuclear	Conv.
Medium range missile	___	___	___	___
Short range missile	___	___	___	___
Primitive air bases	___	___	___	___
Nuclear depots	___	___	___	___
Higher-echelon hqs	___	___	___	___

Total Number of Targets

Since the target acquisition probabilities are applied to the total number of targets, true or false, the number of true targets in each class must be increased by the factors described above.

$$TGTS = TTGTS(1 + DUM + MIS + MOV)$$

where:

TGTS = total targets in each class

TTGTS = true targets present in each class

DUM = fraction of dummy targets in each class

MIS = fraction of misidentified targets in each class

MOV = fraction of unrecognized movement, if retention policy is more than zero days.

Target Acquisition

The fraction of targets in each class acquired in a 24-hour period is based on the percent of knowledge (POK) tables developed by the US Army for NATO and Warsaw Pact forces. These tables represent the combined technical capability of the available collection means under average or standard wartime conditions expected in a war between NATO and the Warsaw Pact. The values reflect a number of assumptions, such as the availability for theater use of certain collection means, collection priorities on both sides, the ability to penetrate enemy air space, the electronic warfare environment, and average weather conditions in Europe.

In order to enhance or degrade these average POK values to reflect the current combat situation represented in MINTSIM, the POK is multiplied by various factors indicating how far off average the current conditions are. Three factors are suggested for initial use: the number of successful reconnaissance sorties (including non-penetrating SIGINT sorties), the theater C^3 index, and whether the target class has maintained radio silence in the period. At some future time when more data are available, other factors may be added by the user.

Reconnaissance Sorties.* The user inputs the number of reconnaissance sorties assumed in developing the average POK value for each target class (RECAV). The user also inputs the degradation in each target class that would occur if no reconnaissance sorties, as defined above, were flown (NOREC). If REC is the actual number of reconnaissance sorties flown in the period, the reconnaissance factor is

$$\{NOREC + (1 - NOREC)REC/RECAV\}$$

NOREC represents the fraction acquired by ground-based and other collection systems.

C^3 Index. The user inputs a number reflecting the theater C^3 index reflecting the average assumed in developing the POK tables. This index implicitly represents the ability of the information collected to be processed, analyzed, presented to the decision-maker, and the transmission of orders, including coordination, to air bases and firing units. The fraction of targets acquired that appear on the target list for decision and allocation is the ratio of the current C^3 index to the average C^3 index

$$C3I/C3IAV.$$

Radio Silence. The user inputs the fraction of targets in each class that would be acquired if all units in the class maintained radio silence (POK)(RADSI). The radio silence factor is 1.0 if radio silence is not in effect for that class.

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* It should be emphasized that reconnaissance sorties include all aircraft (Air Force and Army) whose mission is intelligence, including SIGINT, radar, IR, photo, human, and other sensors. They combine area and pinpoint missions.

Fraction of Targets Acquired. The fraction of targets acquired in each class is unity for developed air bases and the following for all other rear area targets:

$$FTA = (POK)(RADSI)\left(\frac{C3I}{C3IAV}\right)\{NOREC + (1 - (NOREC)\left(\frac{REC}{RECAV}\right)\},$$

where

FTA = fraction of targets acquired in each class

POK = percent of knowledge from table for each class

RADSI = fraction of POK value acquired if all units maintained radio silence (= 1 when radio silence not maintained)

C3I = theater C^3 index

C3IAV = theater C^3 index for average combat conditions in POK table

NOREC = fraction of POK value acquired if no reconnaissance sorties

REC = actual number of reconnaissance sorties

RECAV = number of reconnaissance sorties for average combat conditions in POK table.

Theater Target List

The number of targets on the target list for each target class used by the theater commander to attack rear area targets then becomes:

$$TLST = TGTS(FTA) + TSAV$$

where:

TLST = number of targets of each class on theater commander's target list

TGTS = number of targets (true and false) of each class that can be detected

FTA = fraction of targets acquired in each class in previous period

TSAF = number of targets that are retained from past acquisitions.

TLST is the target list used by the theater commander to allocate resources (conventional and nuclear) for the attack of rear area targets.

Assessment

The assessment of attacks on rear area targets is in two parts. Damage to the enemy is produced only by attacks on true targets. Collateral damage to civilians is produced by attacks on all targets, true or false.

On-Line Forces

The target acquisition submodel does not affect conventional ground combat because the scale is too small for a theater-level model. Target acquisition, however, vitally affects nuclear strikes against on-line forces, by defining the fraction of the maneuver and artillery units whose identity and location are known. This fraction depends on the following:

- length of time on-line
- friendly C^3 index
- friendly mission
- FEBA movement in last period.

Length of Time On-Line. The user inputs the number of days in an inactive situation that is needed to achieve the best possible degree of knowledge of an enemy on-line division and the fraction of maneuver companies and artillery batteries that would be located within 100-200 meters. The program then interpolates for intermediate periods of time.

Friendly C^3 Index. The degree of knowledge is then multiplied by the product of the C^3 index of all commanders in the chain of command from the supported unit to the decision-maker for use by the MMS model, but only by those echelons subordinate to the commander controlling the fire units for actual assessment.

Mission. If the friendly mission is rupture, attack, or defense, the mission multiplier is unity. If the mission is delay, the mission multiplier is a number less than unity specified by the user. If the mission is a counterattack against a successful rupture, the degree of knowledge is zero beyond the first 3 km.

FEBA Movement. If the FEBA has moved more than $E_1 = 0.5$, the user inputs a degradation factor to account for the new terrain, small unit reorganization on both sides, and movement of all units on both sides.

Degree of Knowledge.

$$DOK = (TOLF)(C3I)(MSSN)(FEBF)$$

where:

DOK = degree of knowledge

TOLF = time on-line factor

C3I = C^3 index of appropriate echelons

MSSN = mission factor

FEBF = FEBA movement factor.

Chapter 8

TACTICAL AIR MODEL

FORCES

Initial tactical air forces are described according to the number of aircraft by type, their capabilities, and respective roles of operation. Forces include those in place at the beginning of the conflict and aircraft (by type) brought into the conflict as it continues, in accordance with a predetermined schedule.

AIR BASES

Air bases are of two classes: developed and primitive. Within each class there are two types: those bases within range of enemy short-range missiles (also potentially subject to enemy ground force overrun), and those bases at greater depth from the FEBA which are not subject to attack except by penetrating enemy aircraft or long-range missiles. Air bases may be added (user input schedule) after M-day to reflect new construction.

Each air base class has a daily sortie capability (DSC):

1. DSC_1, for forward developed bases.
2. DSC_2, for rear developed bases.
3. DSC_3, for forward primitive bases.
4. DSC_4, for rear primitive bases.

The user must define the quantity of air bases and the daily sortie capability of each class.

Prior to activation of the adaptive measures (see Chapter 5), all aircraft are based on developed air bases in proportion to all developed air base daily sortie capabilities. For example:

2000 aircraft, 10 forward developed bases @ 300 sorties/day/base

20 rear developed bases @ 400 sorties/day/base.

Aircraft allocation is then:

Theater daily sortie capability = 10 x 300 + 20 x 400 = 11,000.

Air base assignment:

$$\text{Forward developed } (DSC_1) = \frac{3000}{11000} \times 2000 = 546 \text{ aircraft} = AAR_1$$

$$\text{Rear developed } (DSC_2) = \frac{8000}{11000} \times 2000 = 1454 \text{ aircraft} = AAR_2.$$

Developed air bases are also characterized by number of aircraft shelters, tons of supplies, quantity of nuclear weapons, SAMs and ADAs, and aircraft of all types; all in proportion to the daily sortie capability of each base to the theater daily sortie capability.

Primitive bases are used only when the model activates adaptive measures. At that time, all aircraft in the theater are divided between primitive and developed bases in proportion to the total daily sortie capability of both primitive and developed bases.

Using the above example, our new "adaptive" distribution of aircraft to bases is:

for example -

2000 aircraft, 10 forward developed bases @ 300 sorties

20 rear developed bases @ 400 sorties

10 forward primitive bases @ 150 sorties

70 rear primitive bases @ 200 sorties

then:

Theater daily sortie capability =

$$10 \times 300 + 20 \times 400 + 10 \times 150 + 70 \times 200 = 26500.$$

Air base assignment:

$$\text{Forward developed } (DSC_1) = \frac{3000}{26500} \times 2000 = 226 \text{ aircraft} = AAR_1$$

$$\text{Rear developed } (DSC_2) = \frac{8000}{26500} \times 2000 = 604 \text{ aircraft} = AAR_2$$

$$\text{Forward primitive } (DSC_3) = \frac{1500}{26500} \times 2000 = 113 \text{ aircraft} = AAR_3$$

$$\text{Rear primitive } (DSC_4) = \frac{14000}{26500} \times 2000 = 1057 \text{ aircraft} = AAR_4.$$

Supplies, nuclear weapons, and SAMs/ADAs will be proportional to all bases in the same proportion as aircraft allocation.

AIRCRAFT TYPES

There are six types of aircraft available for assignment to conventional or nuclear roles. These types of aircraft reflect the aircraft's capability, and/or pilot-to-mission training.

Type	Description
1	Air Defense Interceptors (ADI)
2	Reconnaissance (REC)
3	Nuclear-only, ground attack (NHA)
4	Conventional-only, ground attack (INT/DAS)
5	Dual-capable, ground attack (CA)
6	Close air support only (CAS)

The user must input the quantity of aircraft by type. As is described under "Aircraft Role Allocation," some of these aircraft may be withdrawn from the INT/DAS and CA roles and put into the CAS role, as the user and situation require. Type 6 aircraft (CAS only) may not be allocated to the INT/DAS and CA roles, i.e., INT/DAS and CA aircraft may fly CAS missions, but CAS (only Type 6) aircraft may not fly INT/DAS or CA missions.

Total losses in the CAS role are found by applying the appropriate attrition* figure to the numbers of Type 4, 5, 6 aircraft carrying out the CAS roles and then summing losses by type.

AIRCRAFT ROLES

Aircraft are allocated to roles on a theater-wide basis according to an input strategy. Operations in the designated roles produce outputs, which in turn affect the course of the air battle, the outcomes of individual ground unit engagements,** and subsequent aircraft role allocations.

Seven roles are considered to which flyable aircraft are allocated:

1. Air Defense Interceptors (ADI). Aircraft in this role will operate with the theater air defense system to engage enemy aircraft when they penetrate friendly air space.

The ADI aircraft do not go through the same role allocation as the other aircraft, but are handled separately. Although some of these aircraft, in reality, may have reasonable air-to-ground capability, they are generally configured specifically for air-to-air combat. To allocate aircraft back and forth between the air-to-air and air-to-ground roles appears to be a complex operation beyond the scope of MINTSIM. In view of this, the allocation of ADI is handled as an input number. Judgment will be required according to the enemy threat and relative enemy capability of friendly and enemy aircraft to establish the input value, which will then remain the same throughout the campaign.

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* This difference in attrition by type of aircraft in the CAS role should reflect not only the survivability of each type of aircraft, but the exposure (loiter) time to enemy fire.

** This, in effect, assumes that aircraft basing and average flight ranges for close air support sorties would be designed to provide equal potential to all on-line divisions. Allowances are made to provide CAS to all divisions as a function of each division's requirement insofar as available CAS sorties permit.

The ADI aircraft are assumed to be operating in conjunction with an air defense control system which has some specified probability of detecting incoming aircraft. (A provision is made should the user wish to reduce the effectiveness of this air defense control system during periods in which the ADI are dispersed for adaptive measures.) The system then directs the ADI to these incoming aircraft for the purpose of intercepting and destroying the penetrating aircraft.

A single probability (POI) is used to represent the entire intercept process against aircraft by type and role.* Included in this probability are the probability that the ground control system successfully detects the penetrator, that an ADI is available to engage, and that the control system can vector the ADI to accomplish a successful intercept. The effective POI is multiplied by a function of the defender's theater C^3 index to take account of degraded C^3.** At the user's option, the POI against aircraft carrying nuclear weapons may differ from the POI against conventional aircraft.

2. <u>Reconnaissance (REC)</u>. Aircraft in this role are assigned the mission of penetrating the enemy air space to acquire intelligence on enemy targets, except for on-line divisions (armies), Class V. For convenience, the target table is repeated:

I. Medium-range missiles (PERSHING, SCALEBOARD, etc.).
II. Short-range missiles (LANCE, PLUTON, SCUD).
III. Airfields and colocated SAMs.
IV. Nuclear custodial units, not colocated with delivery units.
V. On-line division forces, including nondivisional artillery and organic nuclear systems (HONEST JOHN, FROG).
VI. Off-line division forces.
VII. Corps (army), army group (front) headquarters and colocated SAMs.
VIII. Theater supply pool.

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* See page 84.

** See page 65.

The quantity of successful REC sorties is used in computing the list of targets. Assignment of REC aircraft to the reconnaissance role is based on the quantity of aircraft available to this role. Replacement of REC aircraft is by user input schedule.

3. Interdiction and Deep Air Support (INT/DAS). Aircraft in the INT/DAS role penetrate enemy air space and attack all rear area targets except airfields. The user must input the target priority in terms of the percentage of INT/DAS sorties directed against each target class. Two percentages are required for each target class: one for normal conventional operations and one for operations under adaptive measures (dispersal). This will allow the user to alter target priorities as a function of adaptive measures.

INT/DAS aircraft may be intercepted by enemy ADI aircraft. In this model, it is assumed that the pilots of conventional INT/DAS aircraft penetrators, successfully detected and intercepted, become aware of impending enemy ADI attacks and jettison their payloads. All conventional INT/DAS aircraft surviving the air-to-air engagement return to base without attacking their assigned targets.

The user can select two options for INT/DAS aircraft carrying nuclear weapons. One option is that INT/DAS aircraft do not jettison their nuclear payloads when engaged by interceptors, but seek to escape and continue to the target. All nuclear INT/DAS aircraft surviving the air-to-air engagement, therefore, continue to their targets. The probability of an ADI aircraft intercepting and killing a nuclear INT/DAS aircraft, therefore, will differ from the probabilities of intercept and kill of a conventional INT/DAS aircraft. The probability that a nuclear penetrator will kill the ADI will also differ from that of a conventional penetrator.

The other option is for nuclear INT/DAS aircraft to jettison their payloads and engage just as conventional INT/DAS aircraft.

4. Escort (ESC). Aircraft in this role are a user-specified percentage of the INT/DAS + CA aircraft, i.e., of those aircraft allocated to the INT/DAS and CA roles, the percentage of these aircraft to be used in the escort (ESC) role. Aircraft in this role penetrate the enemy air space,

accompanying the DAS, INT, and CA aircraft. Should enemy ADI aircraft intercept these friendly penetrators, the ESC aircraft will engage the enemy interceptors.

5. Counterair (CA). This is an offensive role to destroy all known class III targets, enemy aircraft while parked on the air bases, enemy air base facilities, and surface-to-air missiles (SAM) sites. This role requires deep penetrations into enemy territory. The major targets for the CA are aircraft parked on air bases.

6. Close Air Support (CAS). This role includes all strikes in support of ground forces. Aircraft allocated to CAS are turned over to the ground force model for allocation to the combat-ground unit engagements. Attrition is computed as a function of the number of enemy forces (air defense units) in each engagement, and the mission of the supported forces in the engagement. Aircraft losses for each engagement are tallied over the entire period. Losses are calculated for CAS at division level for Blue and army level for Red.

7. Nuclear Withhold (NHA). These are aircraft which serve as nuclear delivery means should nuclear weapons require aircraft delivery.

AIRCRAFT ROLE ALLOCATION

Allocation of aircraft to these roles is accomplished either by the model as a function of the theater situation and losses, or by user input for each period of the campaign. The user may, by input, control the allocation of aircraft to the various roles and thus input desired strategy to the air model. For example, should the user wish to investigate both the possibility and impact of gaining air superiority early in the campaign, he may (via input) convert all allowable aircraft to the counterair (CA) role in an attempt to destroy as many enemy aircraft, enemy air base facilities, and SAM sites as possible. Such strategies/allocations are possible (via user input) at any time (cycle) during the simulation. In the absence of user-defined aircraft role allocation, the MINTSIM model will use the allocation rules. The following discussion describes the model (logic) for role assignment.

Decisions (i.e., threshold comparisons) are made at the beginning of each period. The percentages to be applied to each role are provided as input for the first period, but these are modified in the subsequent periods according to aircraft loss rates in the air and on the ground. Loss rates are calculated each period and compared to threshold levels that are user inputs. (These thresholds represent the maximum rate of air and ground losses above which sustained operations are in serious jeopardy.) The allocation to the INT/DAS, CA, and CAS roles are then modified by increments (user input) depending on the results of the above computation.

Changes in allocation are based on three average attrition rates. These are the INT/DAS, CA, and by losses on air bases. The general nature of the changes should be towards reducing attrition (if it exceeds the threshold). An examination of Table 7, line 1, shows the following:

a. The loss rates in INT/DAS, CA, and aircraft on air base are less than the user-specified threshold.

b. The user has, under this condition, specified that 5 percent of the CA role aircraft will be removed from the CA role and redistributed with 2 percent going to the INT/DAS and 3 percent to the CAS roles.

This change in allocation—when attrition rates reflect less than threatening losses from enemy air defense—therefore permits more concentration of aircraft against enemy ground forces.

The MINTSIM model permits the user to disperse the aircraft from developed air bases to primitive air bases (autobahns). This dispersal of aircraft is seen as diluting the air base target system and reducing the operational and role assignment due to reduced maintenance and role coordination. The effect of this reduction is expressed as a user input and is used to modify the "desired" role allocation as previously discussed.

Table 7

EXAMPLE OF CHANGES IN ALLOCATION
(per period)

	Comparison Results, Actual Attrition vs Thresholds			Change Increments to Effort by Role (Percent)		
	INT/DAS	CA	Airbase	INT/DAS	CA	CAS
Line 1—>	L	L	L	+2	-5	+3
	L	L	H	+1	+4	-5
	L	H	L	+2	-2	0
	L	H	H	+2	-5	+3
	H	L	L	-3	+4	-1
	H	L	H	-5	+10	-5
	H	H	L	-4	-6	+10
	H	H	H	-6	+16	-10

H - actual attrition > threshold attrition.
L - actual attrition < threshold attrition.

Note 1: If upper limit of effort in any role is achieved, transfers of effort calling for an increase to that role will be ignored.

Note 2: If lower limit of effort in any role is achieved, transfers of effort calling for a reduction in that role will be ignored.

Note 3: If lower limit in CAS role is achieved and transfers of effort call for reduction in CAS with addition to CA, then effort will be reduced in INT/DAS (if available) and added to CA.

Thresholds are attrition rates for theater period as follows:

$$\text{for CA, rate} = \frac{\text{all aircraft in-flight losses in CA role}}{\text{all sorties allocated to CA role}}$$

$$\text{for INT/DAS, rate} = \frac{\text{all aircraft in-flight losses in INT/DAS role}}{\text{sorties allocated to INT/DAS role}}$$

$$\text{for airbase, rate} = \frac{\text{all aircraft lost on air bases each theater period}}{\text{all aircraft assigned to air bases at beginning of theater period}}$$

Figure 14 is a chart showing what aircraft types may be assigned to what aircraft roles.

Aircraft Type	Aircraft Role Assignments: 1 ADI	2 REC	3 NHA	4 DAS	5 CA	6 CAS	7 ESC
1 ADI	X						
2 REC		X					
3 NHA			X				
4 INT/DAS				X		X	X
5 CA			X		X	X	X
6 CAS						X	

Fig. 14—Aircraft Type/Role Assignment

The maximum and minimum allocations for each role limit the allowable change in allocation except for the "panic" mode where:

a. A check is made of the previous period for any successful rupture. If any successful rupture occurred, the air model converts to "panic."

b. A check is made of the FEBA movement in the previous period. If the FEBA moving at this rate will reach the critical line before a user-defined time has expired, the air model converts to "panic."

In the "panic" mode, all aircraft allocated to the INT/DAS and CA roles are converted to the CAS role. If the condition causing the "panic" mode is cleared, the role allocation returns to the values existing at the time the "panic" conversion took place.

AIR BATTLE

Figure 15 is a schematic of the air battle. The friendly aircraft (REC + INT/DAS + CA + ESC + NHA) attempting to penetrate the enemy air space encounter the enemy air defense interceptors (ADI). The friendly escort (ESC) aircraft will engage the enemy ADI as specified by the user, namely, a ratio of ESC to ADI, up to the limit of either the ESC or ADI aircraft.

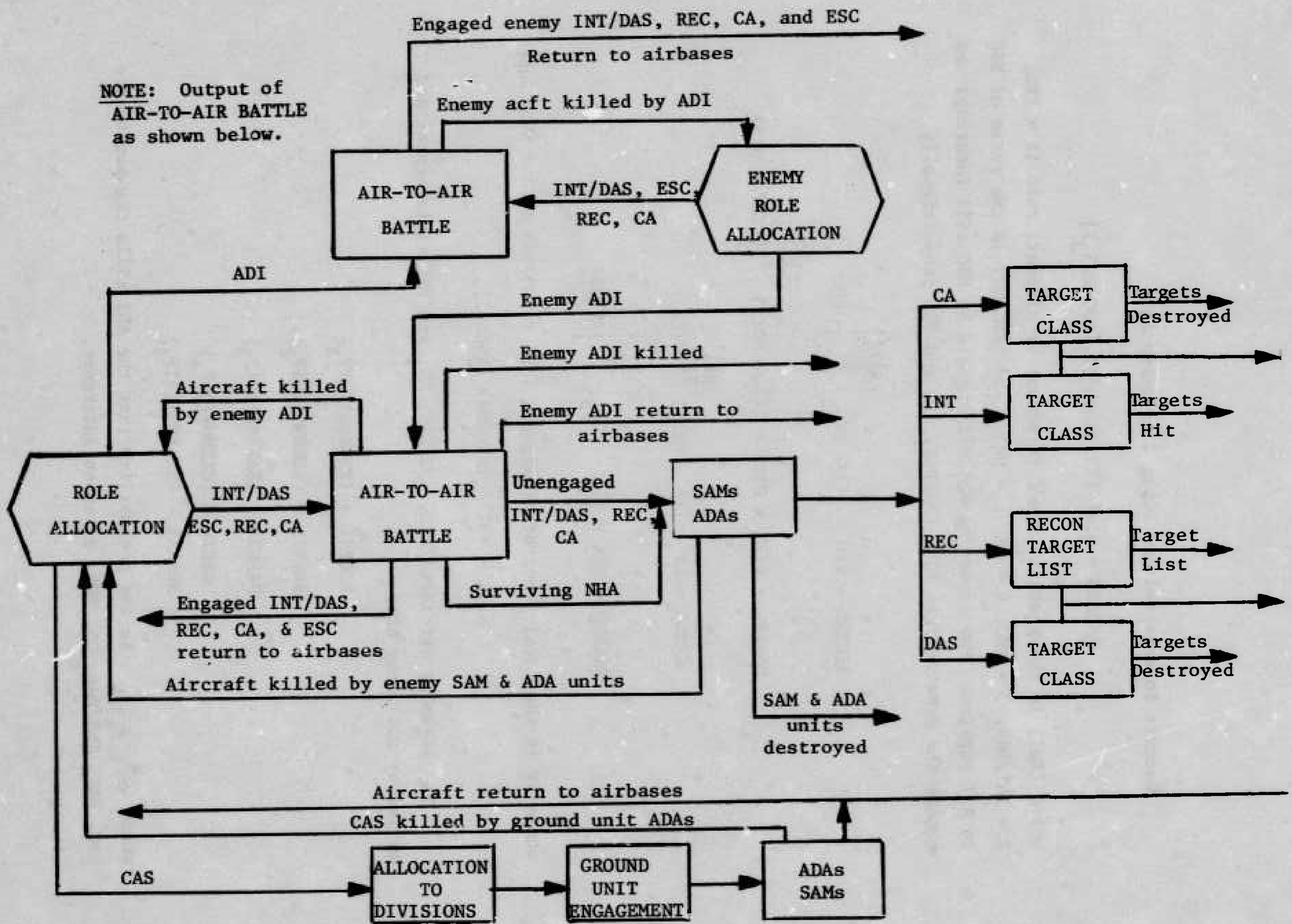


Fig. 15—Air Battle Model

Escorts intercepted and engaged by enemy ADI:

$$ESCENG = \min[(ADI)(ESCADI),(ESC)POI_3)]$$

where (POI) is the probability of intercept by aircraft role (1 = REC, 2 = INT/DAS, 3 = ESC, 4 = CA, 5 = NHA), and (ESCADI) is the ratio of ESC to ADI engaged. Any excess of ADI not engaged by ESC will intercept and engage the penetrators; REC, INT/DAS, CA, and NHA proportionally.

$$RECENG = REC - \left[(1 - POI_1)^{\frac{ADI1}{TF}}\right](REC)$$

$$DASENG = (INT + DAS) - \left[(1 - POI_2)^{\frac{ADI1}{TF}}\right](INT + DAS)$$

$$CAENG = CA - \left[(1 - POI_4)^{\frac{ADI1}{TF}}\right](CA)$$

$$NHAENG = NHA - \left[(1 - POI_5)^{\frac{ADI1}{TF}}\right](NHA)$$

where TF is the total penetrators engaged (REC + INT/DAS + CA + NHA) and

$$ADI1 = ADI - (ESCENG)/(ESCADI).$$

The friendly aircraft (REC, INT/DAS, CA, and ESC) intercepted and killed by the enemy ADI:

$$ESCKIL = (ESCENG)(QIP_1)$$

$$RECKIL = (RECENG)(QIP_2)$$

$$DASKIL = (DASENG)(QIP_3)$$

$$CAKIL = (CAENG)(QIP_4)$$

$$NHAKIL = (NHAENG)(QIP_5)$$

where $QIP_{1,2,3,4,5}$ is the probability that the ADI kills the penetrator ESC, REC, INT/DAS, CA, NHA, given an intercept.

The friendly aircraft intercepted, which engage and kill the enemy ADI:

$$ADESC = (ESCENG)(QPI_1)/(ESCADI)$$

$$ADREC = (RECENG)(QPI_2)/(ESCADI)$$

$$ADDAS = (DASENG)(QPI_3)/(ESCADI)$$

$$ACDA = (CAENG)(QPI_4)/(ESCADI)$$

where $QPI_{1,2,3,4}$ is the probability of killing the ADI engaging each penetrator ESC, REC, DAS, CA.

Friendly aircraft penetrating to targets:

$$(REC + INT/DAS + CA + NHA) - (RECENG + DASENG + CAENG + NHAKIL)$$

Those friendly aircraft which penetrate enemy ADI (PENT) then encounter enemy ground-to-air defense systems (SAMs and ADAs). Should the enemy be operating the air defense control system under the dispersed mode, the user may input a reduced attrition per sortie per aircraft penetrating (ATR_1 = normal attrition, ATR_2 = dispersed attrition) as the result of SAMs and ADAs. Therefore, the number of friendly penetrators ($PENT_{1,2,3,4}$) in each mission killed by enemy SAMs and ADAs are:

$$PKIL_{1,2,3,4} = (PENT_{1,2,3,4})(ATR_{1,2})(ADFUS)$$

where ADFUS is the total number of enemy air defense fire units. (NOTE: SAM units are converted to ADAs by a user-conversion factor.)

This notional air defense fire unit is defined as a small defense site, such as a single gun emplacement. The total number of ADFUS at any time, then, is based on the number of ADA and SAM units present, times their respective conversion factors that identify the number of ADFUS per defending unit. Conversion factors are employed for ADA, low altitude SAMs, and high altitude SAMs. The quantity of ADFUS is reduced as SAM units are destroyed by air attack, but the quantity is increased if replacement SAM units are provided by user input.

Those aircraft which succeed in penetrating the ADI and SAM/ADA units seek to:

a. INT and DAS, as previously stated, seek to destroy targets of military significance (resulting in delays to the enemy in behind the line movements and destruction to Class I, II, IV, V, VII, and VIII targets).

b. The CA aircraft seek to destroy aircraft parked on the ground and enemy SAM/ADA units. A distinction is made between those aircraft parked in the open and those in shelters, due to the variation in vulnerability associated with each. Shelters which are damaged or destroyed are effectively lost. The user may define a repair and new construction rate by inputting, each cycle, the quantity of shelters to be added to the theater inventory. These "new" shelters are added to the air bases using the following rules:

   1) "new" shelters are used to replace damaged or destroyed shelters;

   2) any excess of "new" shelters over the required replacement of damaged or destroyed shelters will go to air bases in proportion to air base sortie capability;

   (OR)

   3) may be withheld and used only as rule 1) allows (replacement of damaged or destroyed shelters).

The number of aircraft at risk on air bases (by type of air base):

$$AARO_{1,2,3,4} = FARP_{1,2,3,4}[AAR_{1,2,3,4} - SHELT_{1,2,3,4}]$$

where:

$$FARP_{1,2,3,4} = \left[1 - \frac{(DSC_{1,2,3,4})(ASD)}{CH}(1 - PTO_{1,2,3,4})\right]$$

$AAR_{1,2,3,4}$ = total aircraft assigned to bases (by type of air base).

FARP = fraction of aircraft at risk (sortie rate, warning, average sortie duration, and time the attack occurs).

$DSC_{1,2,3,4}$ = daily sortie capability (by type of air base).

ASD = average sortie duration.

CH = combat hours in period.

$PTO_{1,2}$ = probability* that aircraft take off upon warning of impending attack.

$PTO_{3,4}$ = probability* that aircraft parked on primitive air bases are not seen or take off upon warning of impending attack.

The total number of aircraft on the ground which are destroyed:

$$ALOSTB = AARO\left[1 - (PKP)^{\frac{(1 - FCASAM)(FAPA)(TAAB)}{AARO}}\right] +$$

$$(AAR - AARO)\left[1 - (1 - PKASA)^{\frac{(1 - FCASM)(FAS)(TAAB)}{SHELT}}\right]$$

---

* The user inputs a PTO for air-to-ground attack of air bases and missile attack of air bases.

where

PKP = probability of kill against parked aircraft in open by each striking aircraft.

FCASAM = fraction of CA sorties allocated to attack SAMs.

FAPA = fraction of striking aircraft attacking air bases which attack parked aircraft in the open.

TAAB = total number of successful penetrating striking aircraft attacking air bases and SAM sites.

PKASA = probability of kill against sheltered aircraft by each striking aircraft.

FAS = fraction of striking aircraft attacking air bases which attack sheltered aircraft. (NOTE: FAPA + FAS = 1.0.)

Ordnance loads are assumed to be suitable for the target distribution.

Attacks on SAM sites are also a part of the CA role. It is assumed that such attacks would take place in some proportion to attacks on air bases. Consequently, an input fraction of CA sorties is allocated to SAM sites.

SAM and ADAs destroyed:

$$SAMLOS = (FCASAM)(PDESAM)(TAAB)(ADFUS)$$

where

PDESAM = probability of destroying air defense unit per attacking aircraft.

CLOSE AIR SUPPORT

Close air support sorties are allocated to subordinates as part of the process of selecting a course of action. Two allocation policies can be specified by the user:

1. CAS sorties equally divided among subordinate units.
2. A specified percent of CAS sorties to the most successful unit on the offense (least successful on the defense), the remaining sorties equally among the remaining units.

Losses to CAS aircraft are calculated for each ground engagement as a function of the supported unit's mission and the number of enemy ADA units opposing the supported unit.

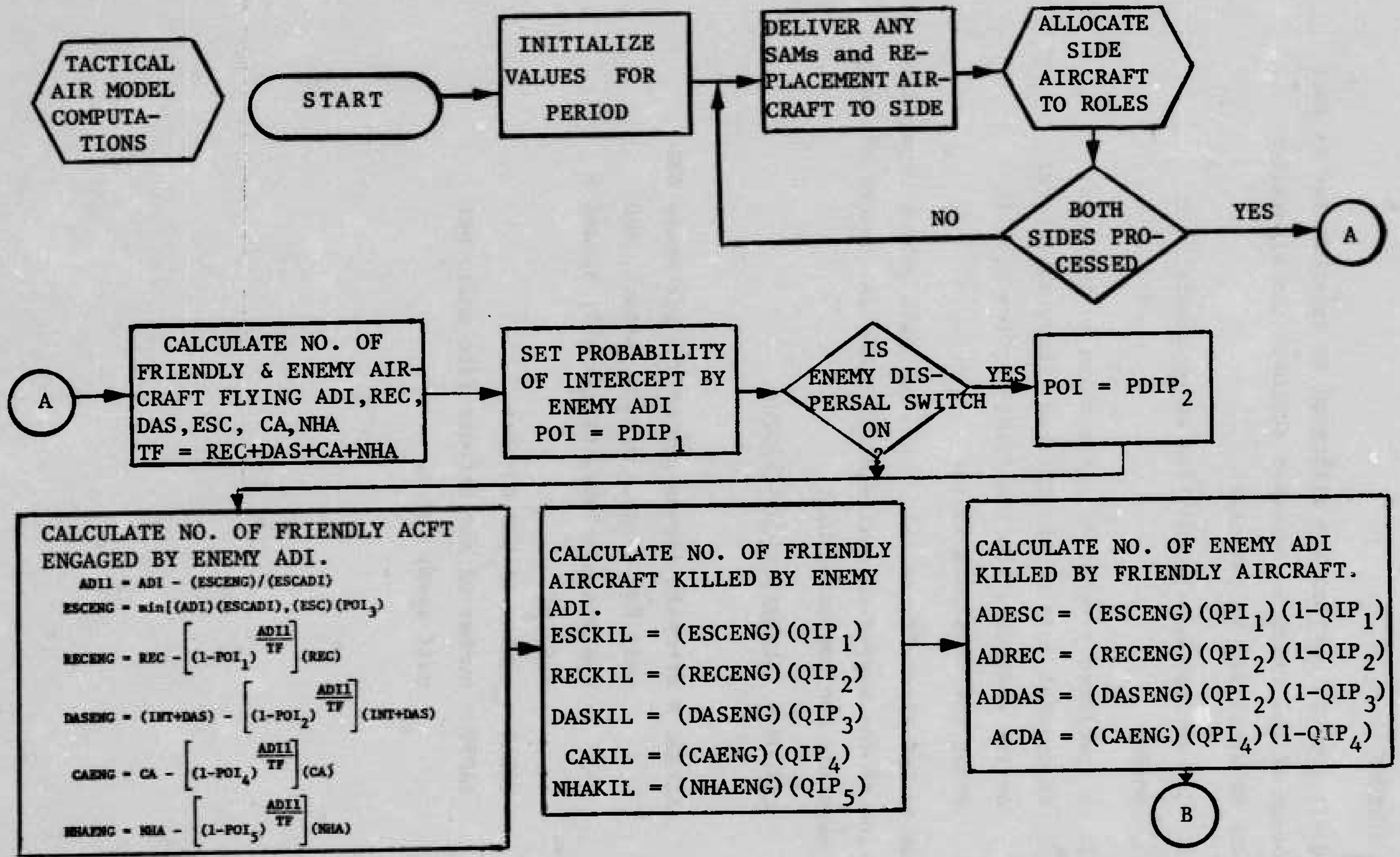
$$CASLOS = (ALPADA)(SQCAS)(AADFU)$$

where

ALPADA = aircraft losses per sortie per enemy ADA unit for delay, defense, attack, and rupture missions, for type 4, 5, and 6 aircraft.

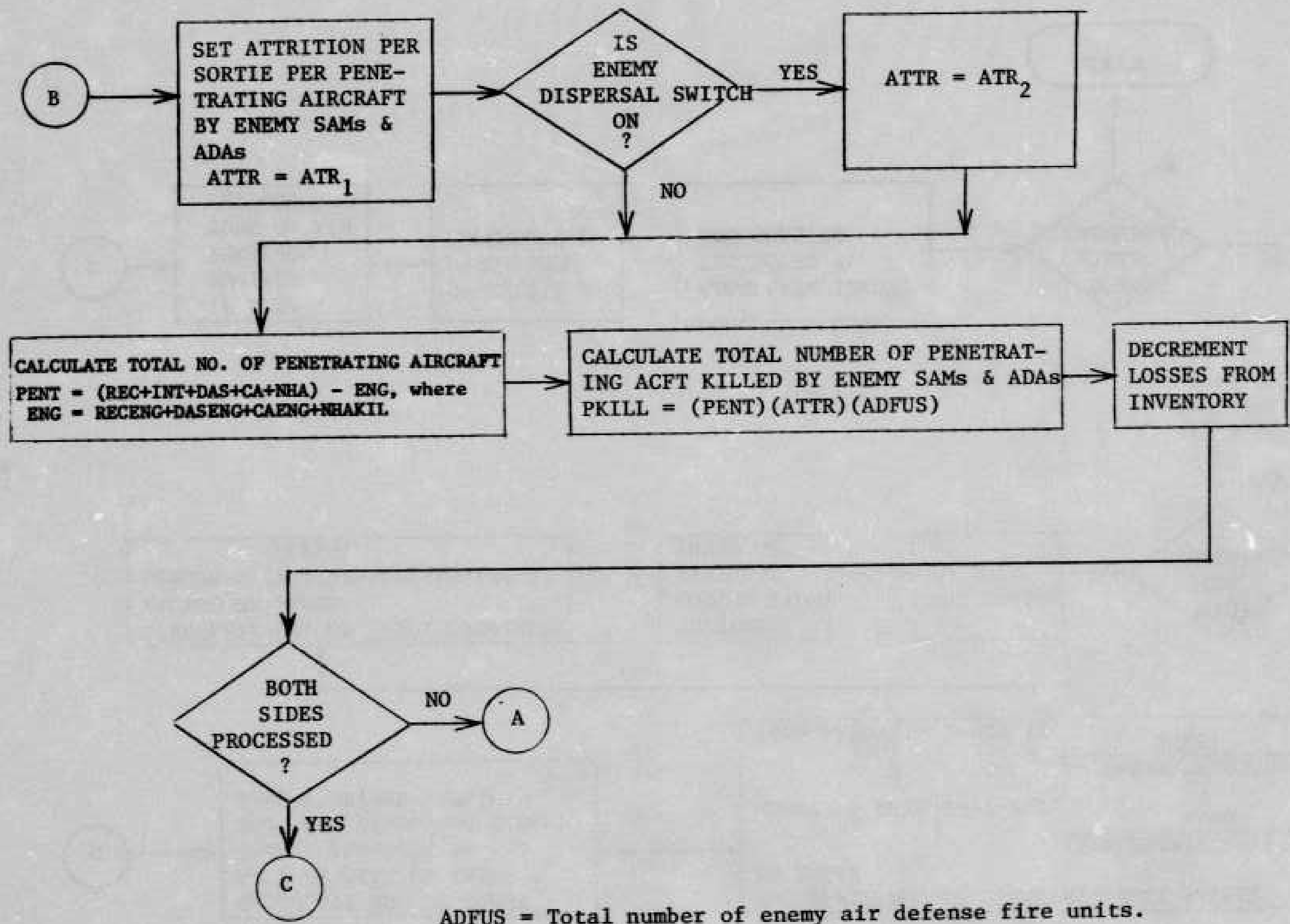
SQCAS = number of CAS sorties.

AADFU = number of air defense fire units per unit enemy force.

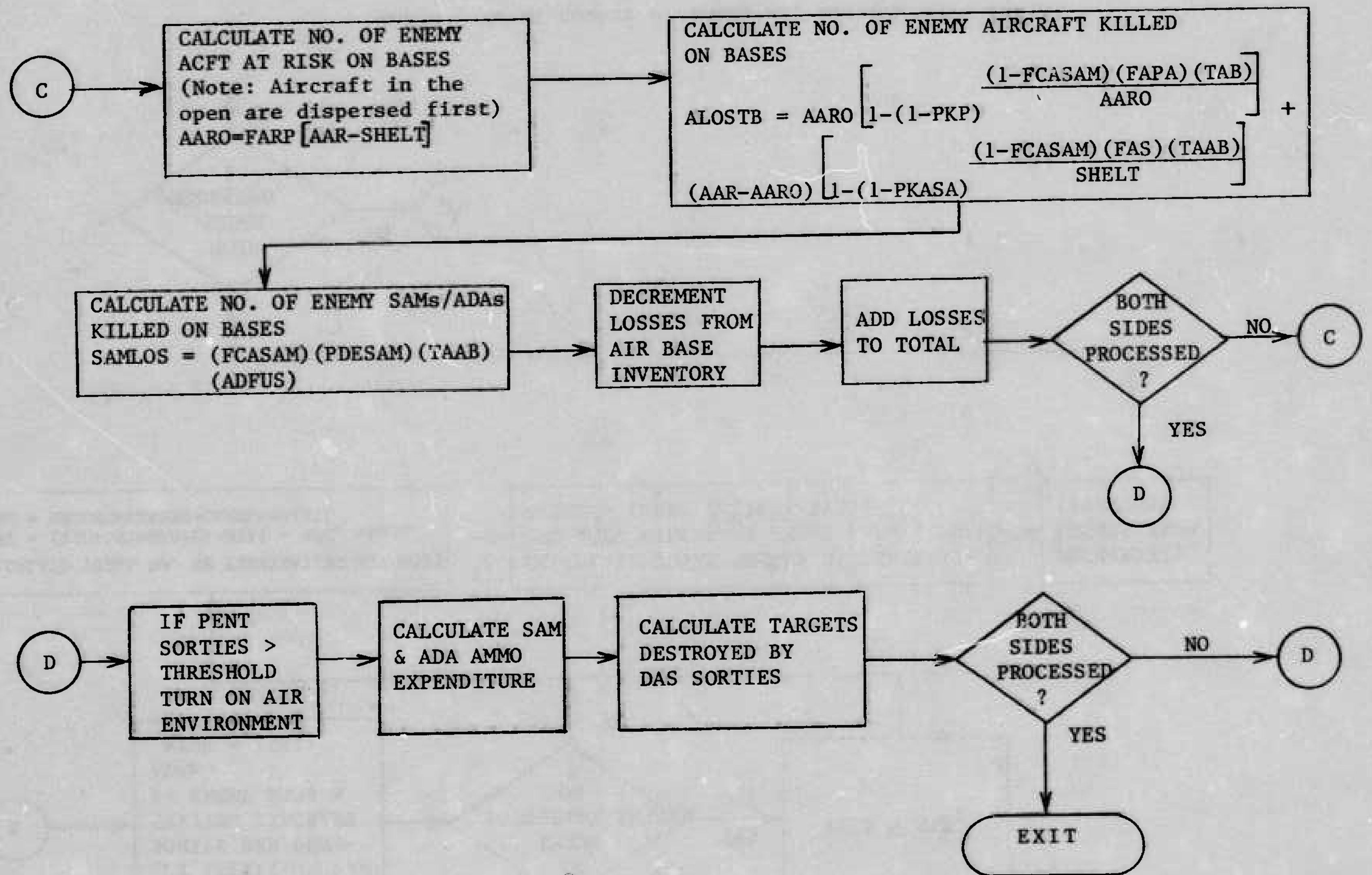


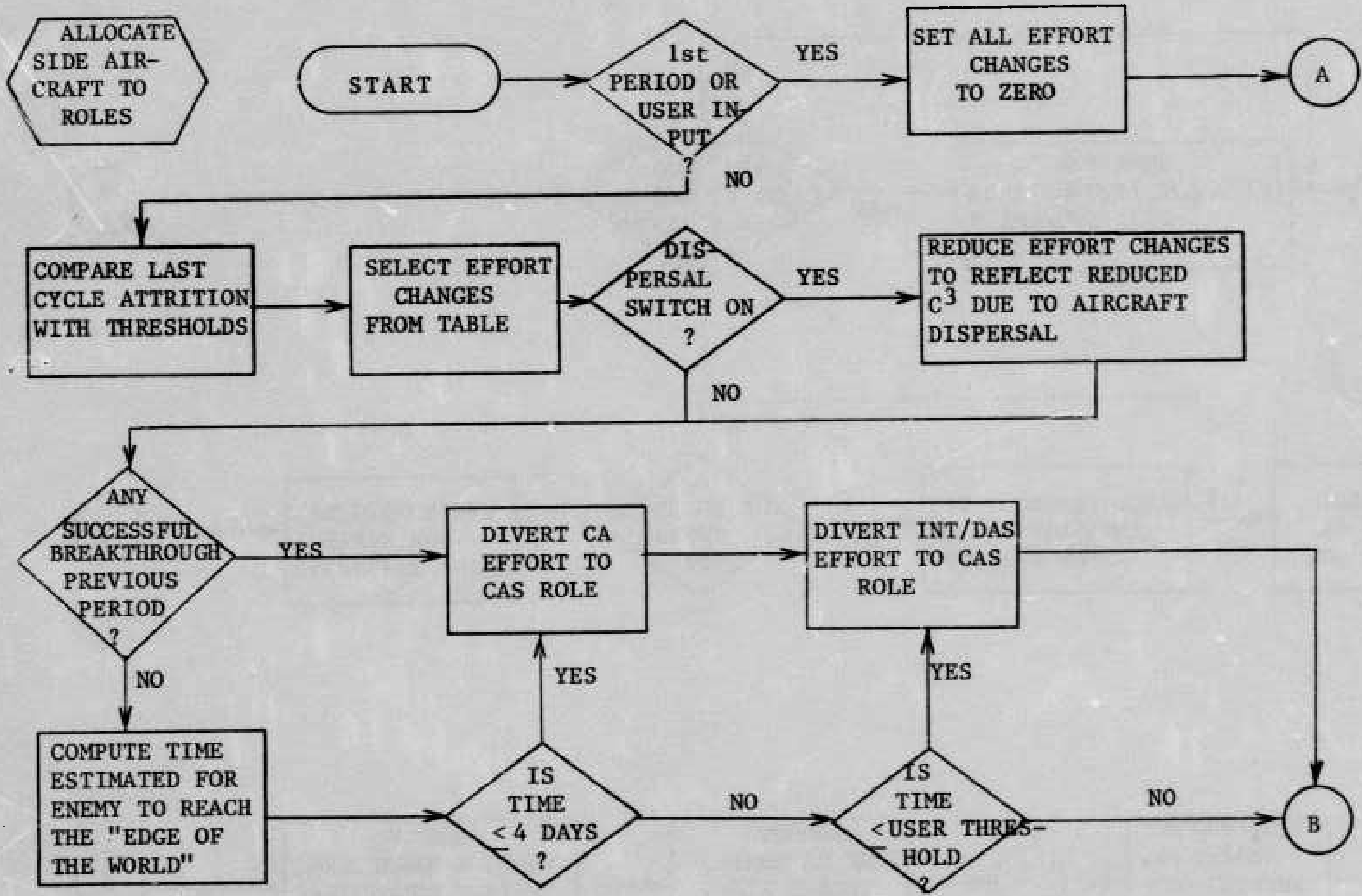
ADI = No. of enemy air defense interceptor acft.
REC = No. of friendly reconnaissance aircraft.
DAS = No. of friendly deep air support.
ESC = No. of friendly escort aircraft.
CA = No. of friendly counterair aircraft.
NHA = No. of nuclear withhold aircraft.

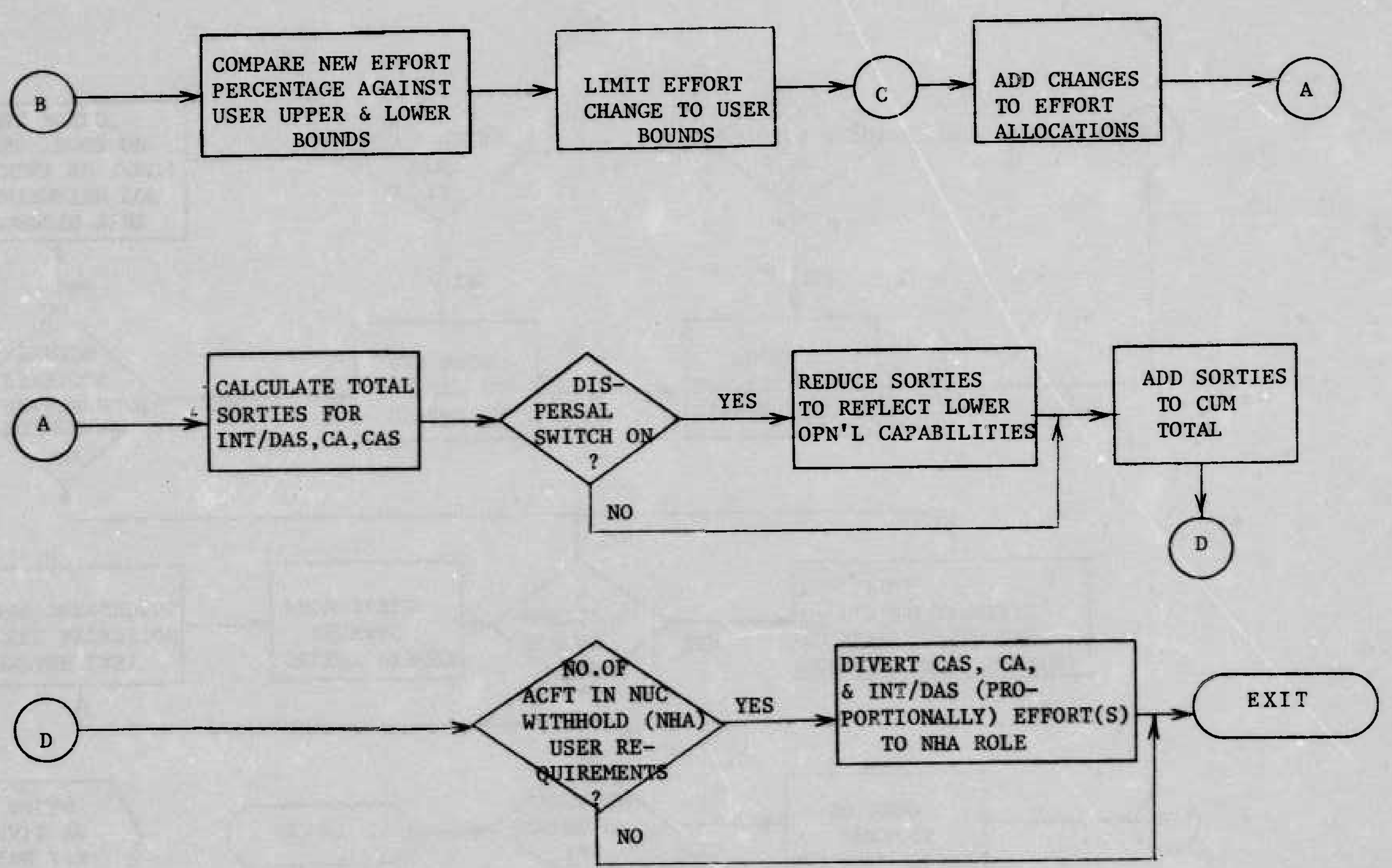
POI = Probability of intercept by enemy ADI.
ESCADI = Percent of ESC engaged by ADI, given intercept.
QIP_1 = Probability ADI kills engaged ESC.
QIP_2 = Probability ADI kills engaged REC.
QIP_3 = Probability ADI kills engaged DAS.
QIP_4 = Probability ADI kills engaged CA.
QIP_5 = Probability ADI kills engaged NHA.



ADFUS = Total number of enemy air defense fire units.


C
CALCULATE NO. OF ENEMY ACFT AT RISK ON BASES (Note: Aircraft in the open are dispersed first) AARO=FARP [AAR-SHELT]
CALCULATE NO. OF ENEMY AIRCRAFT KILLED ON BASES
ALOSTB = AARO [1-(1-PKP) (1-FCASAM)(FAPA)(TAB) / AARO] + (AAR-AARO) [1-(1-PKASA) (1-FCASAM)(FAS)(TAAB) / SHELT]
CALCULATE NO. OF ENEMY SAMs/ADAs KILLED ON BASES SAMLOS = (FCASAM)(PDESAM)(TAAB)(ADFUS)
DECREMENT LOSSES FROM AIR BASE INVENTORY
ADD LOSSES TO TOTAL
BOTH SIDES PROCESSED ?
NO
YES
C
D
D
IF PENT SORTIES > THRESHOLD TURN ON AIR ENVIRONMENT
CALCULATE SAM & ADA AMMO EXPENDITURE
CALCULATE TARGETS DESTROYED BY DAS SORTIES
BOTH SIDES PROCESSED ?
NO
YES
D
EXIT


ALLOCATE SIDE AIRCRAFT TO ROLES
START
1st PERIOD OR USER INPUT ?
YES
SET ALL EFFORT CHANGES TO ZERO
A
NO
COMPARE LAST CYCLE ATTRITION WITH THRESHOLDS
SELECT EFFORT CHANGES FROM TABLE
DISPERSAL SWITCH ON ?
YES
REDUCE EFFORT CHANGES TO REFLECT REDUCED C3 DUE TO AIRCRAFT DISPERSAL
NO
ANY SUCCESSFUL BREAKTHROUGH PREVIOUS PERIOD ?
YES
DIVERT CA EFFORT TO CAS ROLE
DIVERT INT/DAS EFFORT TO CAS ROLE
NO
YES
YES
COMPUTE TIME ESTIMATED FOR ENEMY TO REACH THE "EDGE OF THE WORLD"
IS TIME ≤ 4 DAYS ?
NO
IS TIME ≤ USER THRESHOLD ?
NO
B


B
COMPARE NEW EFFORT PERCENTAGE AGAINST USER UPPER & LOWER BOUNDS
LIMIT EFFORT CHANGE TO USER BOUNDS
C
ADD CHANGES TO EFFORT ALLOCATIONS
A
A
CALCULATE TOTAL SORTIES FOR INT/DAS,CA,CAS
DIS-PERSAL SWITCH ON ?
YES
NO
REDUCE SORTIES TO REFLECT LOWER OPN'L CAPABILITIES
ADD SORTIES TO CUM TOTAL
D
D
NO.OF ACFT IN NUC WITHHOLD (NHA) USER RE-QUIREMENTS ?
YES
NO
DIVERT CAS, CA, & INT/DAS (PRO-PORTIONALLY) EFFORT(S) TO NHA ROLE
EXIT

Chapter 9

NUCLEAR MODEL

INTRODUCTION

The nuclear model consists of a preprocessor, assessment routine, and a postprocessor. The preprocessor converts user inputs into machine-usable form for use by the assessment routine. The assessment routine calculates the damage, casualties, and neutralization produced by nuclear strikes against divisions and rear area targets. The postprocessor converts the output of the assessment routine into degradation of divisional (army) effectiveness for subsequent use by the ground combat model, and enemy aircraft and airfield degradation into sortie reductions for subsequent use by the air model, and losses of nuclear delivery systems, warheads, or conventional logistic capability.

The nuclear model has inputs automatically fed by the C^3 and target acquisition models and feeds changes in C^3 and target acquisition into the ground and air combat models.

APPROACH AND GUIDELINES

There are two classes of nuclear strikes, which are handled separately in MINTSIM:

1. Packages of nuclear weapons (type, yields, delivery systems) employed against enemy divisions to accomplish the mission assigned to a ground commander.

2. Specific allocations of types, yields, and delivery systems against enemy nondivisional targets (nuclear delivery systems, nuclear depots, headquarters, airfields, etc.).

The package concept is adopted because MINTSIM resolves only to NATO divisions and Pact armies. It is unwieldy for a theater-wide model to assess each individual aim point, yield, and delivery system against each targeted element of an enemy division (army). The user defines nuclear packages in accordance with his attack policies, political constraints, target acquisition, and posture of the enemy force.

The allocation of weapons to nondivisional targets is driven by the target acquisition, priority, and availability routines customary in most nuclear assessment models, as constrained by political inputs.

USER INPUTS

There are six classes of user input for the nuclear model:

1. Initial conditions
2. Political constraints
3. Nuclear option triggers
4. Nuclear attack policies
5. Nuclear package preprocessor
6. Damage and defeat criteria.

Each of these is described in the following paragraphs.

Initial Conditions

Each identified unit in the model that controls or delivers nuclear weapons has in its status file the number of weapons by delivery system, type, yield, and configuration that are initially allocated to it.

The weapons may be colocated with launchers or they may be in custodial units. Weapons colocated with launchers are nuclear artillery rounds in artillery batteries, missile warheads on launchers, and bombs on board aircraft.

The user specifies the number of custodial units initially assigned to each division, corps, army group, and theater for NATO and each army, front, and theater for the Pact. Weapons assigned to a subordinate echelon are equally distributed among the custodial units of that echelon. Weapons to be launched are colocated with the launcher.

Air-delivered weapons are in underground storage sites on developed air bases and in custodial units on primitive air bases.

The user, if desired, may specify a delivery schedule by delivery system, type, and yield for weapons arriving in the theater after war begins. These weapons augment the theater reserve and may be assigned by the theater commander in the next decision cycle after they arrive.

Political Constraints

The top decision-maker in MINTSIM is the theater commander on each side. Hence, the user must input political constraints to simulate the control exercised by the national command authorities.

The political constraints have two purposes: to control escalation by the enemy, and to limit collateral damage by one's own nuclear weapons.

Escalation Control. Escalation control is determined by a user input that specifies employment options or upper limits to employment options for both sides, including response as well as initial use. The concept is to provide as much flexibility as possible in order not to lock the user into a prescribed set of constraints and to permit the user to change the constraints from run to run within a few minutes.

A suggested format for escalation control is shown below:

Constraint	NATO	Pact
Maximum number of weapons to be employed in one decision cycle.	xx xx xxx unlimited	xx xx xxx unlimited
Maximum yield to be employed.	x xx xxx unlimited	x xx xxx unlimited
Maximum depth beyond FEBA that may be attacked.	xx xxx xxx unlimited	xx xxx xxx unlimited
Delivery systems excluded.	cannon xx xx xx aircraft	cannon xx xx xx aircraft
Targets excluded from nuclear attack.	airfields nuclear delivery systems nuclear depots headquarters reserve forces	
Duration of nuclear strike (must be less then cycle time).	x x x	x x x
National forces that may not be struck.	USSR DDR Czech Polish	US FRG UK French Dutch Belgian
National territory that may not be struck.	FRG DDR Czech Polish	FRG DDR Dutch Belgian
Other.		

These political constraints require the force elements on both sides that are explicitly counted in the model to have a location in terms of distance from the FEBA and a nationality. National boundaries must also be specified in the ground combat schematic.

The number of elements for each class is suggested. The programmer may desire the flexibility produced by a larger number of escalation control constraints, either within the categories or by adding additional categories.

A second element in escalation control is to specify the response to enemy employment of nuclear weapons. The user must also specify whether the theater commander is authorized to make a nuclear response to attack in the next decision cycle (within specified constraints), if the option is militarily preferred by the MMS system, or whether the theater commander must wait for political approval that requires one or more additional decision cycles.

Four categories of response options are recommended:

1. Ignore enemy use.
2. Respond within same constraints as initial use, if MMS system so recommends.
3. Match perceived enemy constraints, which may not be the same as actual constraints.
4. Escalate by increasing numbers, yields, depth, targets, or delivery systems, to one level beyond enemy's perceived employment.

All four categories of response, except No. 1, require a specification of the political response time by nuclear decision cycles. Depending on the user's choice of the nuclear decision cycle (4, 6, 12 hours), the response time may allow a nuclear response to be examined or chosen in the next decision cycle, or after one, two, or three succeeding cycles.

If response option No. 1 is chosen, no nuclear option may be examined in the MMS submode. If response options No. 3 or No. 4 are chosen, at least one NATO Army Group or Pact Front is required to use nuclear weapons in the appropriate period, although the actual selection of the package and its employment will be determined by the MMS system.

Calculating Collateral Damage. It is desirable not to restrict MINTSIM to a single method for calculating collateral damage because the military effect of different methods may be one of the potential uses of the model.

Two methods have been in use for calculating collateral damage:

1. Maximum allowable number of civilian casualties, i.e., receiving more than stated effects from a nuclear strike.
2. Excluding towns above a specified population from more than stated effects of a nuclear strike.

The first method provides civilian casualties more simply than the second. The theater is divided into areas of equivalent population density (excluding major cities) in much the same way as terrain types are treated in existing theater simulations.* The number of civilian casualties are assessed by summing the area out to the specified effect level for all weapons in a population density class. This area is then multiplied by the population density for each class and summed to obtain the total number of civilians affected.

The first method compares the resulting number of civilians with the specified allowable maximum. If it is exceeded, the option is rejected.

The second method requires the user to locate and specify the area and population of all towns above the threshold population. This is a relatively straightforward task for on-line divisions and armies. The divisional target arrays required for the preprocessor (described on pp. 114, 115) can be superimposed on specified terrain, including towns. A major

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* See page 136 for an example.

study, however, would be needed to insure that a limited number of samples could be chosen to cover reasonably accurately all situations that might develop. The method is not suitable for calculating collateral damage from attacks on rear targets (such as nuclear launchers, headquarters, air bases) because they are not explicitly located in MINTSIM. It would enormously complicate the model to require all potential nuclear targets in the rear to be explicitly located and moved. Moreover, the rapid growth of some areas, especially in West Germany, is known to make existing census data invalid.

Pending completion of the studies necessary to use method No. 2, method No. 1 is recommended.

Specifying Collateral Damage. Civilian casualties are employed in two ways in MINTSIM; battle assessment after both sides have chosen their course of action, and to evaluate candidate courses of action. In the latter case, the commander evaluates E_5, the goal of minimizing collateral damage. This is defined as:

$$E_5 = 1 - \frac{\text{civilian casualties}}{\text{max tolerable civilian casualties}} .$$

If E_5 is negative, the option is rejected. If E_5 is not negative, it becomes one of the elements in evaluating an option. The following four definitions of maximum tolerable civilian casualties are suggested:

1. Absolute number in a decision cycle.
2. Percent of population in the estimating commander's area.
3. Ratio of civilian to military casualties in the estimating commander's area.
4. Ratio of civilian casualties inflicted by the estimating commander's own weapons to civilian casualties inflicted by enemy weapons in his sector. (Applies only to response options.)

The maximum tolerable civilian casualties in enemy territory may differ from that in friendly territory. Thus, four values are needed: two for NATO and two for the Warsaw Pact.

The following format is suggested:

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* For example, Stuttgart and Hannover are estimated to be growing at a rate of 0.5 km per year.

	NATO Weapons		Pact Weapons	
	on NATO Territory	on Pact Territory	on Pact Territory	on NATO Territory
Absolute number of civilian casualties	___	___	___	___
Percent of population	___	___	___	___
Civilian/military ratio	___	___	___	___
Friendly/enemy ratio	___	___	___	___

Relaxation of collateral damage constraints in the response to enemy use of nuclear weapons must be specified by the user as a separate part of the response generator.

The following format is suggested:

	NATO	Pact
1. Friendly territory total civilian casualties	xxx xxxx xxxxx unlimited	xxx xxxx xxxxx unlimited
2. Enemy territory total civilian casualties	xxx xxxx xxxxx unlimited	xxx xxxx xxxxx unlimited

Separate limitations for NATO and the Pact should be given. This will require a population density analysis over the entire terrain to be incorporated into the model, including Poland, Czechoslovakia, and East Germany on the Pact side; West Germany, Netherlands, and Belgium on the NATO side.

Nuclear Option Triggers

A trigger specifies the conditions under which the theater commander will examine nuclear options in determining his course of action. Until a trigger is activated, no nuclear options may be examined.

The user inputs (1) whether triggers are predictions made by the MMS model or actual events, and (2) whether nuclear employment is mandatory or optional.

<u>Triggers</u>. The following triggers are suggested for the theater commander on each side:

1. Successful rupture in at least one Corps (NATO).
2. Distance to final defense line less than __ km (NATO).
3. Distance to final defense line greater than __ km after __ days (Pact).
4. Sortie capability of nuclear-capable aircraft less than __ (NATO).
5. Enemy use of nuclear weapons (NATO and Pact).
6. Specified by user.

<u>Successful Rupture</u>. The concept of a rupture is described in Chapter 11. If a successful rupture is not contained or sealed off, the rupture becomes decisive and the campaign terminates.

<u>Distance to Final Defense Line</u>. As described in Chapter 4, the user inputs the final defense line for NATO which, if the Pact breaches it in force, defines failure of NATO's mission. Even without a rupture, NATO will then face a choice between defeat or escalation to nuclear war. If the distance from the FEBA to the line is 0 km, the trigger is an event and nuclear options are considered in the next theater decision cycle. If the distance is greater than 0 km, the trigger is a prediction.

<u>Pact Failure</u>. If the Pact advance is so slow that it has failed to reach a specified distance between the border and NATO's final defense line, it is a possible trigger for employing nuclear weapons as an alternative to possible stalemate.

<u>Nuclear Aircraft Sorties</u>. Significant loss of nuclear capability is usually considered a trigger for nuclear employment. The vulnerability of air bases to nuclear attack suggests that the trigger be confined to nuclear-capable aircraft. This trigger, however, might be generalized to the loss of a specified NATO nuclear capability. There is no equivalent for the Pact because of Soviet long-range aviation and MRBM/IRBM which are considered in sanctuary for MINTSIM.

Enemy Use. If enemy use is predicted, a preemptive attack might be considered. If enemy use has occurred, then the appropriate response option is considered.

User Specified. This trigger is to provide flexibility for the user. At a specified number of days of conventional combat, which might be zero, the user might specify that one side would initiate nuclear war in response to assumed events outside the model, rather than in response to events in the model.

Political Response Time. Each trigger must have a political response time (in multiples of the decision cycle) to represent the delay between the theater commander's request and NCA approval to use nuclear weapons. These delays may range from zero to a given number of decision cycles. If it is zero, the theater commander may (or must if the user specifies a mandatory use of nuclear weapons) decide to use nuclear weapons in the current decision cycle. If the decision time is later, the theater commander does not consider nuclear options until the appropriate time, unless other, shorter triggers intervene. The theater commander may also determine in a later decision cycle that the trigger no longer applies.

Nuclear Attack Policies against Divisions

Since individual aim points for nuclear weapons to be used against divisions do not exist in MINTSIM, provision must be made to account for different targeting policies that attacking commanders may adopt. These policies are user inputs.

Zone Attacked. On-line divisions engaged in battle are divided into three zones for purposes of nuclear attack: forward of the artillery, customarily 0-5 km from the FEBA; the artillery zone 5-8 km from the FEBA; and the rear zone beyond 8 km from the FEBA.*

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* If longer range artillery such as RAP or the newer US and Soviet pieces are employed, the artillery zone may be extended beyond 8 km.

The use of nuclear weapons against on-line divisions may be concentrated in a single zone, any pair of zones, or against all three.

Conventional Exploitation. The attacking commander may plan his nuclear fires as a preparation for immediate exploitation with conventional forces. This can affect the damage and defeat criteria used for assessing the effect of nuclear fires. Or, the attacking commander may decide not to combine nuclear fires with a conventional attack, at the user's option.

Target Acquisition. The nuclear submodel also has the capability to vary the commander's nuclear fire planning in accordance with the quality of target acquisition available and his concept of operations. This element of the nuclear submodel allows a user to investigate the military consequences of different nuclear fire planning concepts on each side. The user may specify a concept that nuclear weapons will be delivered only against acquired targets. If not enough targets are acquired to fire all of the weapons in the package(s) allocated to the commander, the package is reduced to match the target acquisition. On the other hand, the user may specify a policy in which suspected targets may be attacked or likely avenues of approach or counterattack fired on as part of the commander's scheme of maneuver for his conventional forces. In this case, all of the allocated weapons may be fired, but not all at precisely identified and located targets.

The user input options are summarized below:

Zones Attacked	Yes	No
Forward of arty	___	___
Arty	___	___
Rear	___	___
Fire on acquired targets only	___	___

Nuclear Package Preprocessor

It is suggested that an off-line preprocessor be developed to assist the user to develop nuclear packages for use against enemy divisions and to provide the data base for the MINTSIM nuclear assessment routine against enemy divisions.

The preprocessor should have the following capabilities:

- Explicit representation of all elements in a division area down to at least company and, preferably, platoon.
- Assessment of casualties (damage) from simultaneous employment of many nuclear weapons with a variety of damage criteria against different classes of enemy elements: tanks, APCs, weapon crews, exposed personnel, civilians with different protection factors, etc.
- Expected values of assessment as a function of delivery system CEP, target location error, attack policy, target division deployment area, and configuration.

The input requirements for the preprocessor are division target arrays and damage and defeat criteria. The outputs are the number of casualties to personnel in maneuver companies, artillery batteries, C^3 elements, and other; and the number of maneuver companies (artillery batteries) defeated or neutralized.

Although each nation on both sides has different types of divisions and these types differ among nations, it is suggested that the initial MINTSIM preprocessor use a standard Pact and a standard NATO division for the following missions as a minimum:

Mission	NATO	Pact
Post-penetration (viable rupture)		x
Attack	x	x
Defense	x	x
Delay	x	
Reserve (2d ech)	x	x
On the march	x	x

Two target arrays should be designed for at least the post-penetration, attack, defend, and delay missions for the minimum and maximum frontage and depth that the user anticipates will occur in any sector of the conventional or nuclear battle. This will allow the nuclear submodel to account for massing and dispersal on the impact of nuclear packages on the target division, or the number of packages required to produce a given effect.

It is also suggested that the preprocessor be run for two extreme target acquisition assumptions: 100 percent knowledge, and pattern fire to allow flexibility in calculating the impact of the derived target acquisition on the effectiveness of the nuclear package. A very rough preliminary guide to the kind of output such a preprocessor would produce is shown in Table 8 below for packages consisting only of a single yield.

Table 8

IMPACT OF DIVISION DEPLOYMENT AND TARGET ACQUISITION ON EFFECTIVENESS OF NUCLEAR FIRES

Yield	Average No. of Co/Bty Defeated per Weapon			
	7 km		27 km	
	Perfect	Pattern	Perfect	Pattern
2	2.4	1.4	1.4	0.22
10	3.7	2.5	2.5	0.55
50	6.6	5.5	2.8	1.4
200	11	11	5.5	4.1

Damage and Defeat Criteria

The preprocessor requires a user input that defines (1) the level of nuclear effect to produce damage or a casualty; (2) the fraction of casualties or damage in a unit (usually a company/battery) to make the unit ineffective; and (3) the fraction of ineffective small units to make a division ineffective.

The user also defines, for the first two factors, the damage/casualty level for prompt and permanent ineffectiveness, delayed and permanent ineffectiveness, temporary ineffectiveness or neutralization, and risk to friendly troops and civilians.

Casualty Criteria. Current criteria for casualties and damage have been developed for the nuclear planning officer in the field, not for two-sided simulation analysis. Thus, they are safe-sided in order to minimize uncertainties. Casualty and damage criteria understate the tactical impact of nuclear effects on the enemy; risk criteria overstate the impact of nuclear effects on friendly troops and civilians. A two-sided analysis should account for the tactical impact of all weapons effects whether or not they are included in field manuals.

The user defines casualty criteria for two tactical situations: (1) a nuclear attack on an enemy division as a prelude to a conventional attack within an hour or two, or on a rear area division on the march where neutralization is the purpose of the attack; and (2) a nuclear attack without a follow-up conventional exploitation where destruction rather than neutralization is the purpose of the attack.

Nuclear Attack with Conventional Follow-up. The following nuclear effects should be considered in developing criteria for nuclear attack on an enemy division as a preparation for a subsequent conventional attack:

1. Early transient incapacitation by radiation doses above ___ rads.

2. Light damage to equipment, particularly antenna and optical equipment breakage.

3. EMP effects on radios, radars, and tactical computers.

4. Thermal burns on face and hands.

5. Delay for damage assessment and reporting status up the chain of command.

Nuclear Attack without Conventional Follow-up. Two sets of casualty and damage criteria are suggested: the current US criteria and Soviet criteria derived from intelligence sources. At the user's option, both sides could use the same criteria for estimation and assessment; or, each side could use its own criteria for estimation and a single set for the actual battle assessment.

Nuclear Attack on Nuclear Launchers. A more demanding set of criteria is usually specified for attacks on enemy nuclear delivery systems in both Soviet and US manuals in order to preclude the ability to launch. Such criteria should be used for the estimation process. In assessment, however, the impact of lesser nuclear effects should be taken into account, particularly when missile and air nuclear strikes must be coordinated, possibly with follow-on conventional attack. A few hours delay in a missile crew's ability to launch may prevent it from launching at all, if the political time window for a nuclear strike is only a few hours.

Defeat Criteria for Company/Battery Targets. For both estimation and assessment purposes, the following criteria for the defeat of maneuver companies and artillery batteries are suggested:

Unit	No Conventional Attack	Conventional Attack
Mnvr Co	≥ ___ rads to 50% of APC/tank crews ≥ ___ rads to 50% of APC/tank crews	≥ ___ rads to 50% of APC/tank crews and > ___ rads or 50% light damage to all elements.
Arty Bty	≥ ___ rads to 50% of gun crews ≥ ___ rads or _ cal/ cm^2 to 50% of gun crews	≥ ___ rads to 50% gun crews or 50% light breakage on pieces

The upper value in the center column is the current US criterion; the lower value is the derived Soviet criterion. There is no official criterion for nuclear preparation fire prior to a conventional attack for either side, so only a single criterion is suggested.

Defeat Criteria for Nuclear Launch Crews. The following criteria are suggested for estimation and assessment of nuclear launch crews where delays of several hours have no effect, and for assessment where delays of several hours have an effect.

Immediate Defeat	Delay
___ rads to crew	_____ rads to crew
or	and
severe damage to launcher	moderate damage to missile

Nuclear Assessment

The preprocessor enables the user to develop tables for each nuclear package with the following format:

NATO PACKAGE NO.

Casualties	Pact Postures					
	Successful Rupture	Attack	Defend	Delay	Reserve	March
Mnvr Pers	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
Arty Pers	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
C^3 Pers	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
Other Pers	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
Unit Defeated Co/Bty w/ Conv Attack	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
Co/Bty w/o Conv Attack	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx xx xx	xx xx	xx xx
HQ.	xx xx	xx xx	xx xx	xx xx	xx xx	xx xx
Supplies	xx xx	xx xx	xx xx	xx xx	xx xx	xx xx
Nuclear Launcher	xx xx	xx xx	xx xx	xx xx	xx xx	xx xx

Legend:

		Tgt Acquisition	
		Good	Poor
Divisions	Massed	xx	xx
	Dispersed	xx	xx

Division Defeat Criteria. The criterion for defeating a division force by a nuclear or combined nuclear-conventional attack should not be determined on the basis of the total number of nuclear casualties in the division. Applying criteria, such as those shown on p. 118, to 50 percent of the maneuver companies and 75 percent to the artillery batteries, will produce only about 10 percent casualties to a division. Even though 10 percent is far below the usual 30 percent criterion often used in conventional combat as a defeat, many military analysts agree that a division suffering such defeat to its combat companies and batteries would be ineffective as a division until it had been reconstituted.

It is further suggested that two nuclear effectiveness multipliers be computed for a package: one when the attacked division does not engage in a conventional battle after the nuclear strike, and another when it does, using, for example, the defeat criteria suggested above.

NUCLEAR PACKAGES

Definition

A nuclear package is a set of nuclear weapons specified by number, type, yield, and delivery system which is sufficient to render ineffective a unit of specified type and size (together with its normally colocated support) organized and engaged in a specific mission in a ZOA of x km when the nuclear weapons effects are evaluated for specified defeat criteria, with a specific level of target acquisition on target elements.

Generation

Nuclear packages may be homogeneous as to yield and delivery systems, but are more likely to be heterogeneous. Packages are generated in a preprocessor by applying various trial packages against a prepared target array for a unit of the specified size, type, mission, and ZOA in the light of specified defeat criteria. Each trial package which just meets the defeat criteria becomes a nuclear package. As

there are an infinite number of possible packages, all foreseeable constraints on package composition must be applied. For example, constraints are likely to limit the number or types of weapons in the package, the acceptable delivery system, yields, tolerable collateral damage, and area of application.

The composition of each nuclear package is presented in a format similar to that of Table 9.

Table 9

PACKAGE COMPOSITION

Package	Components: Weapons & Delivery System			
	Number	Type	Yield	Delivery
A	x	x	x	155mm
	xx	xx	xxx	203mm
B	xx	x	x	155mm
	x	x	xx	203mm
C	etc.			

NOTES: Target: Pact Div in atk ZOA __ km.
Defeat Criteria: individuals ___ rads; one co/btry ___% personnel; div (army) ___% mnvr cos, and ___% arty btry.
Target Acquisition: medium.

Application

In MINTSIM, a running tally is kept of nuclear weapons available to each commander. Comparison of the inventory with the package contents will indicate what packages are entirely or partially feasible. If a nuclear trigger has been activated, the MMS model will determine whether a nuclear option is preferred and which subordinate command(s) should receive the nuclear package(s). Packages are considered for use only against units on-line or in reserve/second echelons. When use of a package has been authorized and is desired, the package is considered to be applied at the start of the period of use. Its

effects degrade the target unit's C^3 index and combat effectiveness for assessments of the ground battle, as indicated in the next section.

Effects. The preprocessor generates effects data for a complete package applied under specified target acquisition conditions against a type unit with a specified mission on a chosen ZOA. The effects of each package are run on a damage assessment model which can resolve targets to company (preferably platoon) level for extremes of target acquisition and zone of action, and for each type unit in each feasible mission. Effects are tabulated for all runs in the format shown on page 119.

Using the appropriate package table and mission of the target unit, effects are interpolated for actual ZOA, target acquisition (degree of knowledge), and for fractional packages (e.g., inadequate delivery system prevents use of full package authorized.

For assessment purposes, the data in the appropriate table are used and interpolated, then fed to the C^3 model, the ground combat model (unit effectiveness, firepower, and supply), and the unit state files.

NUCLEAR ATTACK OF OTHER TARGETS

General

The nuclear attack of targets other than on-line divisions and armies is controlled by the theater commander. This portion of the MINTSIM model is treated in approximately the same way as many other nuclear models, e.g., IDANUC.*

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* WSEG Report 275, IDA Tactical Nuclear Warfare (TacNuc) Model, July 1975, UNCLASSIFIED.

Target Priorities

Of the seven classes of targets (other than on-line divisions and armies), the user specifies those that have a higher priority than on-line forces. The target acquisition model (see Chapter 7) determines the number of acquired targets in each class by the two range classes for friendly delivery systems. It should be noted that some of the acquired targets may be false.

Nuclear and Conventional Attacks

The acquired targets that cannot be attacked at all because of political constraints are deleted from the list. Those targets that cannot be attacked by nuclear weapons are earmarked for conventional attack.

Assignment of Weapons to Targets

The remaining targets may be struck by nuclear weapons. Those with a higher priority than on-line forces are assigned weapons by type, yield, and delivery system according to the following logic, although the numbers may be different for each side.

1. In order of priority, the user inputs the fraction of acquired targets in each class that may be struck up to the lesser of the permitted number of weapons or the number of targets.

2. The user supplies a nuclear damage expectancy (DE) table that provides the DE for each yield-delivery system-target combination, and a minimum DE below which no nuclear attack will be made.

3. The user also supplies a conventional damage expectancy table for each weapon-delivery system-target combination.

4. Those targets where conventional attack by n sorties exceeds the minimum DE are earmarked for the conventional attack.

5. The remaining targets are assigned the lowest yield meeting the minimum DE, using short-range missiles first, medium-range missiles and aircraft last.

6. If weapons remain, the MMS system is operated to determine whether and how many weapons are required (up to the political limit) for attacks of engaged forces.

7. If weapons remain unassigned within the political constraints, the same system is used to assign these weapons to targets of lower priority than on-line forces.

Nuclear Panic Mode

Under some conditions, the target priority system can be overridden by emergency events, called a panic mode. If a successful rupture occurs in one or more corps, the MMS system is operated first. If any weapons remain, they are assigned to rear-area targets in order of priority as before.

Nuclear Assessment

Except for point targets, such as nuclear launchers, the details of assessment of airfields, logistic facilities, and other targets are not described. The available assessment routines for these targets may dictate which of them is most suitable for incorporation.

Chapter 10

IMPROVING UNIT STATE

GENERAL

MINTSIM has two procedures which will improve the conventional state of ground units: increasing the number of subordinate units assigned (reserves or reinforcements) and increasing the combat effectiveness of units by introducing replacements or resupply.

Reinforcements are introduced into the theater according to a user-supplied schedule and may be assigned to subordinate units directly as specified by the user (e.g., a post-mobilization Belgian brigade to a Belgian division) or by being entered into theater reserve and following MINTSIM procedures for using reserves.

Reserves may be assigned to subordinate commands by the MMS submodel each period. Delays before the reserve can be used are specified, varying according to the command level at which reserve is being assigned, what echelon reserve comes from, and where it is to go. Reserves are handled as divisions (NATO) or armies (Pact).

Replacements are handled as individuals of one of four types: combat (armor and infantry); C^3; artillery, and "other." The arrival schedule and rate is specified by the user, as are the fractions of the several types. Normally, a specified fraction of all replacements is taken for rear services; the remainder are allocated according to need (headquarters needs taking precedence over unit needs). When nuclear usage has occurred, different fractions are allocated to rear services and forward units and headquarters. Over time, the mix of arriving replacements can be varied by presimulation input in response to nuclear use.

Resupply deals with tons of supply not specified as to class or major item identification. Tons of resupply available are allocated in a normal mode or an emergency mode, according to whether all units are above or below a specified unit critical supply level.

Units which have been "destroyed" by enemy nuclear strikes may be reconstituted upon attainment of a specified personnel and resupply level, provided a minimum time to reconstitution has passed.

REINFORCEMENT

Reinforcement is the arrival in theater of combat units of division or army size after M-day. Combat unit arrival schedules are specified by the user. Units are available for assignment by theater on or after the day specified. Since MINTSIM does not deal with combat units of less than division (Pact army) size, all arriving units are treated as numbered divisions (armies) unless designated by the user for assignment to a specific existing unit. Thus the user might specify that a brigade-sized unit arriving at M+3 will be assigned to a particular division. There will not be an additional division picked up, but the existing division state, combat effectiveness, and requirements will be increased upon arrival of the reinforcing brigade. If the arriving unit is earmarked for assignment to a headquarters of corps, army, troop or front level, the arriving unit will be picked up as an additional NATO division or Pact army, regardless of its actual size or strength. For this reason, the user must exercise special care in preparing the arrival schedule for reinforcing units. Several arriving combat battalions and/or brigades would preferably be listed as a single division-sized unit or earmarked for reinforcement of specific in-theater divisions. An arriving corps or army (NATO) should be scheduled as "so-many divisions, and one corps (army) HEH."

Artillery and missile units arriving in-theater after M-day likewise may be earmarked for assignment to a particular division/army. If not earmarked, they are treated as a theater reserve and can be allocated with other fire support (FS) by the MMS submodel.

RESERVES

Reserves are carried as whole numbers of divisions (NATO) or armies (Pact). To keep the MMS submodel reasonably simple without departing too far from real-life possibility, upper limits are set for the number of units which may be in reserve, as follows:

Theater	3
Army Group	2
Corps	1

At the beginning of each cycle, the theater virtually reconstitutes a reserve up to its limit, selecting divisions in the following priority:

a. AG reserves, selecting first the weaker division from the AG with the highest force ratio (FR). Repeat, if possible.

b. (If there is no AG reserve) Weakest division from the corps that will have the most favorable (if theater is on defense; unfavorable, if theater on offense) FR above a user-specified corps FR threshold after the division is withdrawn. Repeat as necessary.

Theater applies the MMS, committing 0-3 divisions to AGs, with appropriate delays. An actual (i.e., non-virtual) reserve division is delayed one day, theater to AG. A virtually-withdrawn division is not delayed, theater to same AG; but is delayed by one day, theater to new AG. (Note that virtually-withdrawn divisions must be tagged according to their AG and corps of origin.)

If any AG now has an available reserve of less than 2 divisions, the AG reconstitutes the reserve by virtually withdrawing divisions from its corps as described for the theater.

Each AG applies the MMS, committing 0-N divisions ($2 \leq N \leq 5$) to corps, with appropriate delays. An actual (i.e., non-virtual) reserve division is delayed one day, AG to corps. A virtually-withdrawn division is not delayed, AG to same corps; but is delayed by one day, AG to new corps (total of two days from theater to corps, therefore, if the AG is also new).

In MMS calculations, theater and AG should degrade the effectiveness of committed reserves because of delays, as described in the ground combat model.

The depth of a reserve position changes with adaptive measure at corps level (but not at AG or theater), as the depth of on-line divisions changes. Thus we will have two standard depths for reserve units at corps level and one each at AG and theater. The greater depth will have a longer delay before use, reflected in both MMS calculations and in assessment as a lowered combat effectiveness during the period of commitment.

Reserve divisions will be separated laterally for nuclear safety. It is believed that this will not affect the time to commit; but a check of yields, damage radii, and deployments will have to be made before we can be sure. Theater reserves are located laterally within the sector of 1st echelon Fronts or Army Groups.

RESUPPLY

Supply status is kept by tons for each unit represented. Each unit and the theater, less represented subordinate units and HQ, is characterized by a desired or normal supply level U_iDL, an actual supply level U_iAL, and a critical supply level U_iL^*. The critical supply level is some user-supplied constant K times the normal level ($U_iL^* = KU_iDL$). There are, then, a theater actual level $ATL = \sum_i U_iAL$ and a theater critical level, $TL^* = \sum_i U_iL^*$.

Tons of supply with the theater and with each unit may be expended or destroyed during each combat period. Expenditures vary according to the intensity of ground combat; losses are the result of enemy action.

Supplies arriving in the theater are allocated in accordance with total user shortfall, $US_i = \sum_i (U_iDL - U_iAL)$ and total user critical shortfall, $UCS_i = \sum_i (U_iL^* - U_iAL)$. Input tonnage, IP, may undergo shrinkage for a poor C^3 index; it is then allocated by theater as follows:

a. $ATL > TL^*$ (actual tons more than critical tons)

(1) $IP \leq US$. Theater retains nothing; each user receives $\frac{U_iS}{US} \cdot IP$.

(2) $IP > US$. Theater retains IP - US tons; each user receives U_iS.

b. $ATL \leq TL^*$

(1) $IP \leq UCS$. Theater retains nothing; each user receives $\frac{U_iCS}{UCS} \cdot IP$.

(2) $IP > UCS$. Theater retains nothing; each user receives $U_iCS + \frac{U_iS}{US}[IP - UCS]$.

All user allocations are subject to shrinkage prior to use because of the unit C^3 index described in Chapter 6, p. 65 and adaptive measures described in Chapter 5, p. 52.

REPLACEMENTS

Losses to units in-theater are measured in four classes of personnel: Type A (infantry and armor), B (artillery), C (C^3), and all other. Replacements arrive in-theater in numbers of each type on a schedule specified by the user.*

Of arriving replacements, a fixed fraction (for conventional war and a different fixed fraction for nuclear war) is taken out for meeting the needs of unrepresented theater units. The balance of arriving replacements are then allocated directly to division (army) and HEH (priority) and then to the division elements and artillery battalions in proportion to their shortages.

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* This degree of resolution, while consistent with the theater scope of the simulation, will not permit MINTSIM to address many quantitative and qualitative problems of interest.

Each division/army and each artillery battalion is characterized in each category of personnel by a desired or normal personnel level, U_iDL, an actual level, U_iAL, and a critical level, U_iL*. Like resupply, the critical level for personnel is given by constant K (derived from a user input) times the normal level. U_iL* represents the strength level of one type of personnel at which the unit reaches an unacceptable level of effectiveness in that personnel function. If the user says that 50 percent is the unacceptable level of performance, Fig. 10 would indicate that U_iL* for "other" personnel is 28 percent of U_iDL or K = .28. For Type A personnel in conventional war, K can be derived as .66 from the same figure.

For the theater there can be developed, for each type of personnel, two values: actual theater level, $ATL = \Sigma U_iAL$, and theater critical level, $TL* = \sum_i U_iL*$.

Personnel of each type are lost as nonbattle casualties or to enemy action in each period. Losses to enemy nuclear packages by type are a function of the enemy package, the enemy targeting policy, the enemy C^3 index, the deployment or dispersal or ZOA and depth of the friendly unit, the percent of knowledge POK and degree of knowledge about the targeted unit, and the nature and mission of the targeted unit.

Personnel arriving in theater are subject to shrinkage as a result of theater C^3 Index, and to set aside for rear areas as described above. The remainder are allocated to units in the same manner as resupply tons are allocated. Total user shortfall, US, is calculated as the sum for all units of $U_iDL - U_iAL$. Total user critical shortfall, UCS, similarly $= \sum_i U_iL* - U_iAL$. Personnel available for allocation to theater requirements and unit requirements are allocated as follows:

A if ATL > TL*

(1) and IP $\leq$ US. Theater retains none, each unit receives $\frac{U_iS}{US} \cdot IP$.

(2) if $IP > US$. Theater retains $IP - US$, each unit receives U_iS.

B if $ATL \leq TL^*$, and

(1) $IP \leq UCS$. Theater retains none and each unit receives $\frac{U_iCS}{UCS} \cdot IP$.

(2) $IP > UCS$. Theater retains nothing; each user receives $U_iCS + \frac{U_iS}{US}[IP - UCS]$.

RECONSTITUTION

Units whose unit capability, as defined in Chapter 4, p. 44, falls below a user-specified value (e.g., .65) must be withdrawn into theater reserve. They may not again be used in the normal MMS mission assignment process until their capability exceeds a different user-specified value (e.g., .85), and their supply level is greater than U_iL^*.

The assignment of personnel replacements of the required types to units thus removed from combat is accomplished by the routine just described.

To represent the time lag involved in withdrawal for reconstitution and to permit assimilation of the many replacements, reconstituted units may not be considered for missions sooner than X periods (days) after being withdrawn as ineffective. This is a minimum period regardless of how soon they are re-manned and resupplied.

Chapter 11

GROUND BATTLE

BATTLEFIELD DESCRIPTION

The MINTSIM model uses the same battlefield representation as is currently used in the CEM. Distances along the direction in which forces attempt to move are measured in kilometers. Distances along the "front" are measured in "minisectors" (see Fig. 16). Any quantity of minisectors may be employed across the entire width of the theater, with the space between minisector boundaries expanding and contracting under the influence of terrain, total battlefield width, urban areas, and other factors that would influence the movement of forces.* As shown in Fig. 17, the effect of the terrain features are the varying widths of the minisectors as they go through the mountains and other influential features. The realism of the simulation then, depends in part on the accuracy with which the planner can depict the probable real-life flow of forces.

Ultimately (for the computerized version of MINTSIM), the battlefield, terrain, and population density description will have to be translated into a rectangular coordinate system as suggested in Fig. 18 and Fig. 19. As will be seen later, any significant influence on movement, as a result of physical and/or man-made barriers, can be handled in the terrain description.

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* One input to the model is the minimum number of minisectors a division (Blue), army (Red) front may occupy.

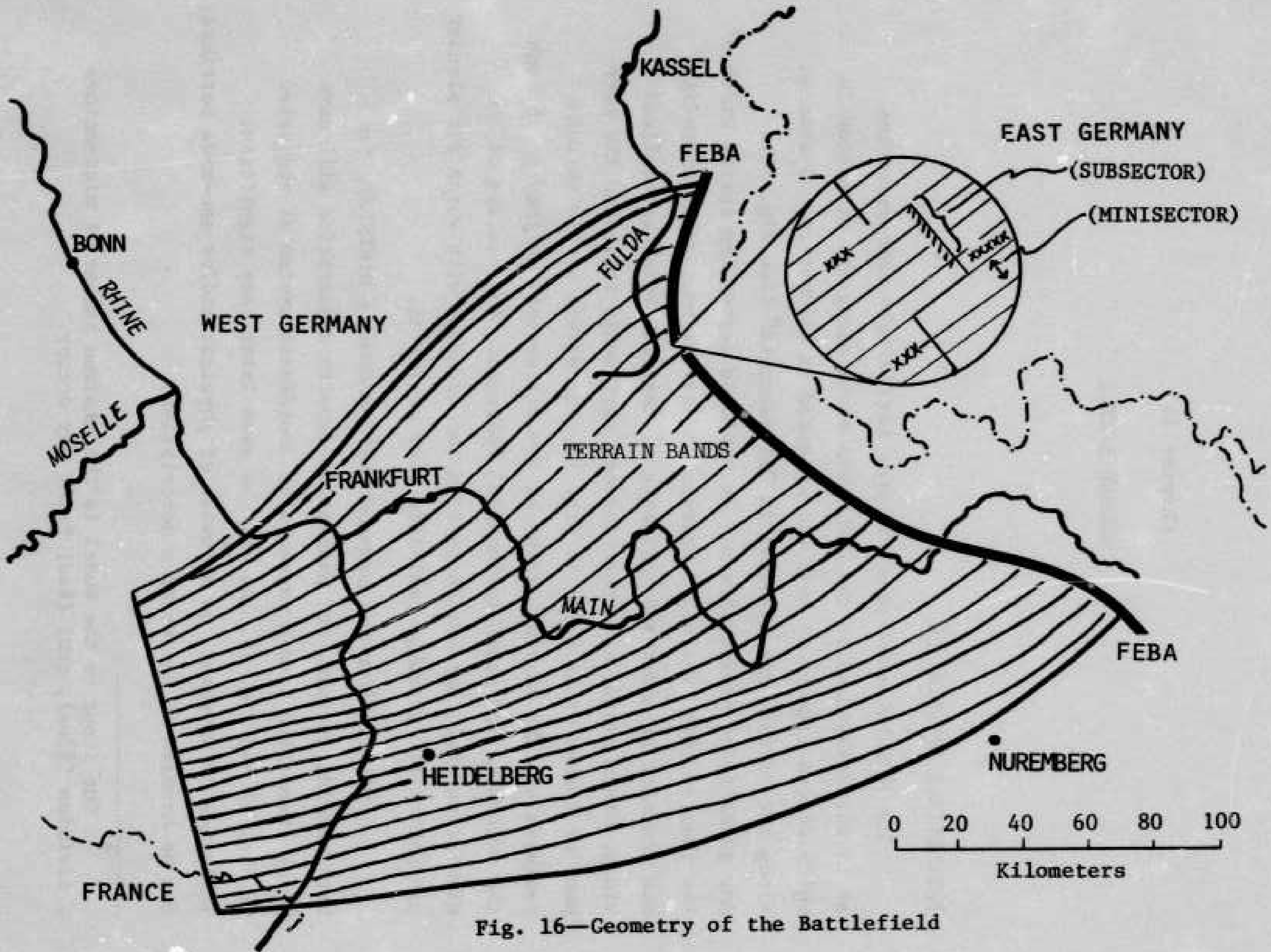

Fig. 16—Geometry of the Battlefield

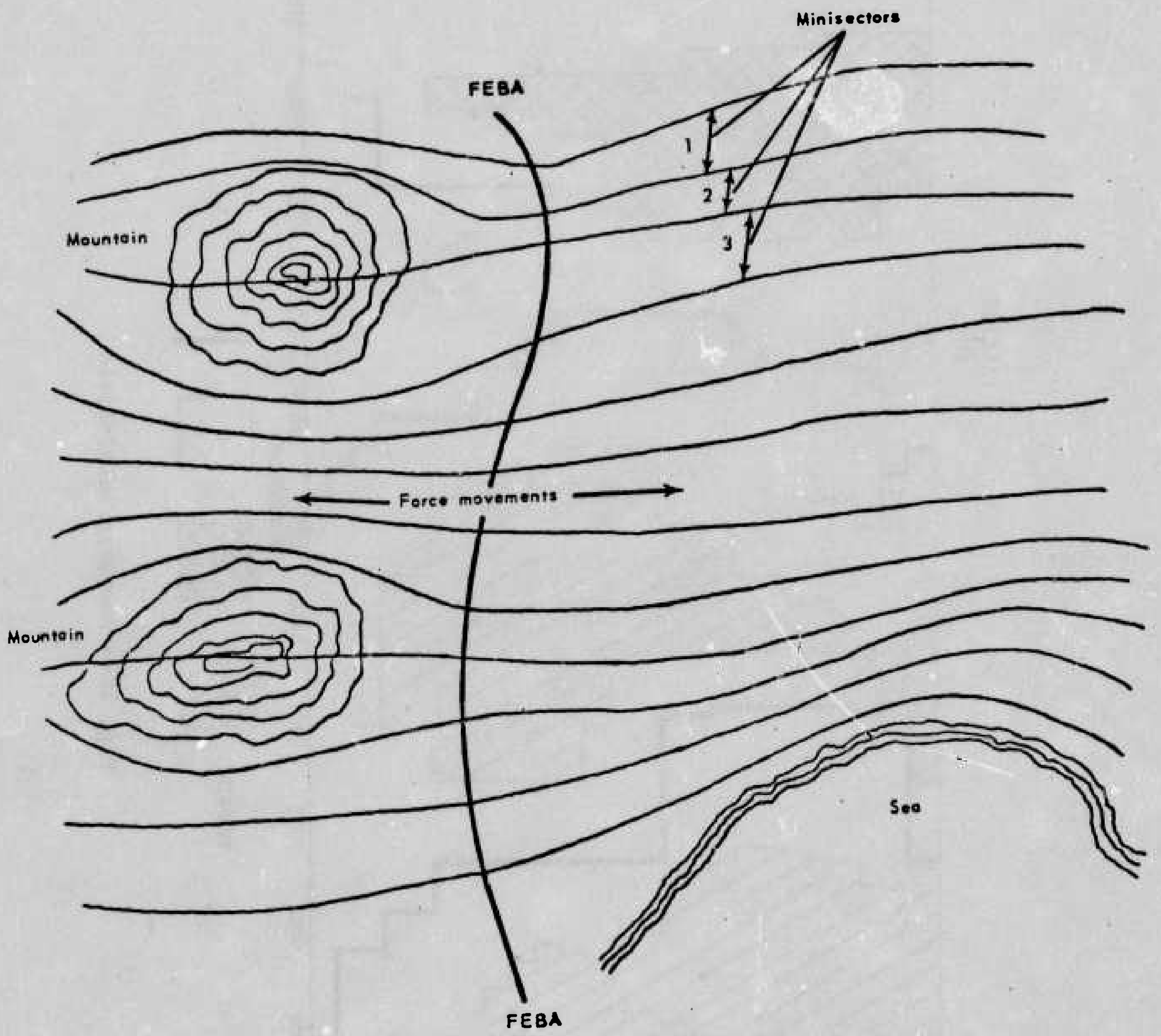

Fig. 17—Terrain and Minisectors

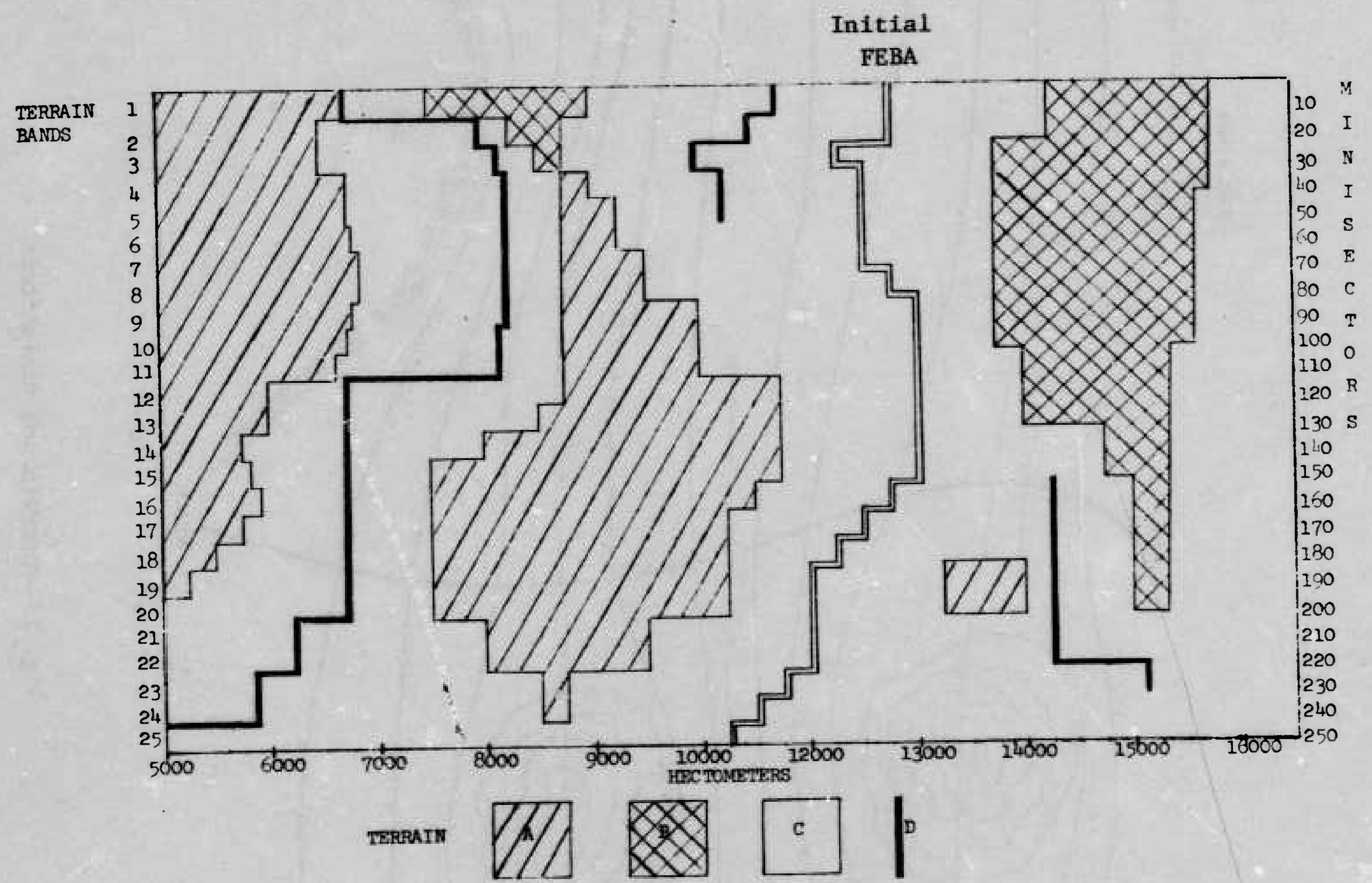

Fig. 18—Schematic Battlefield

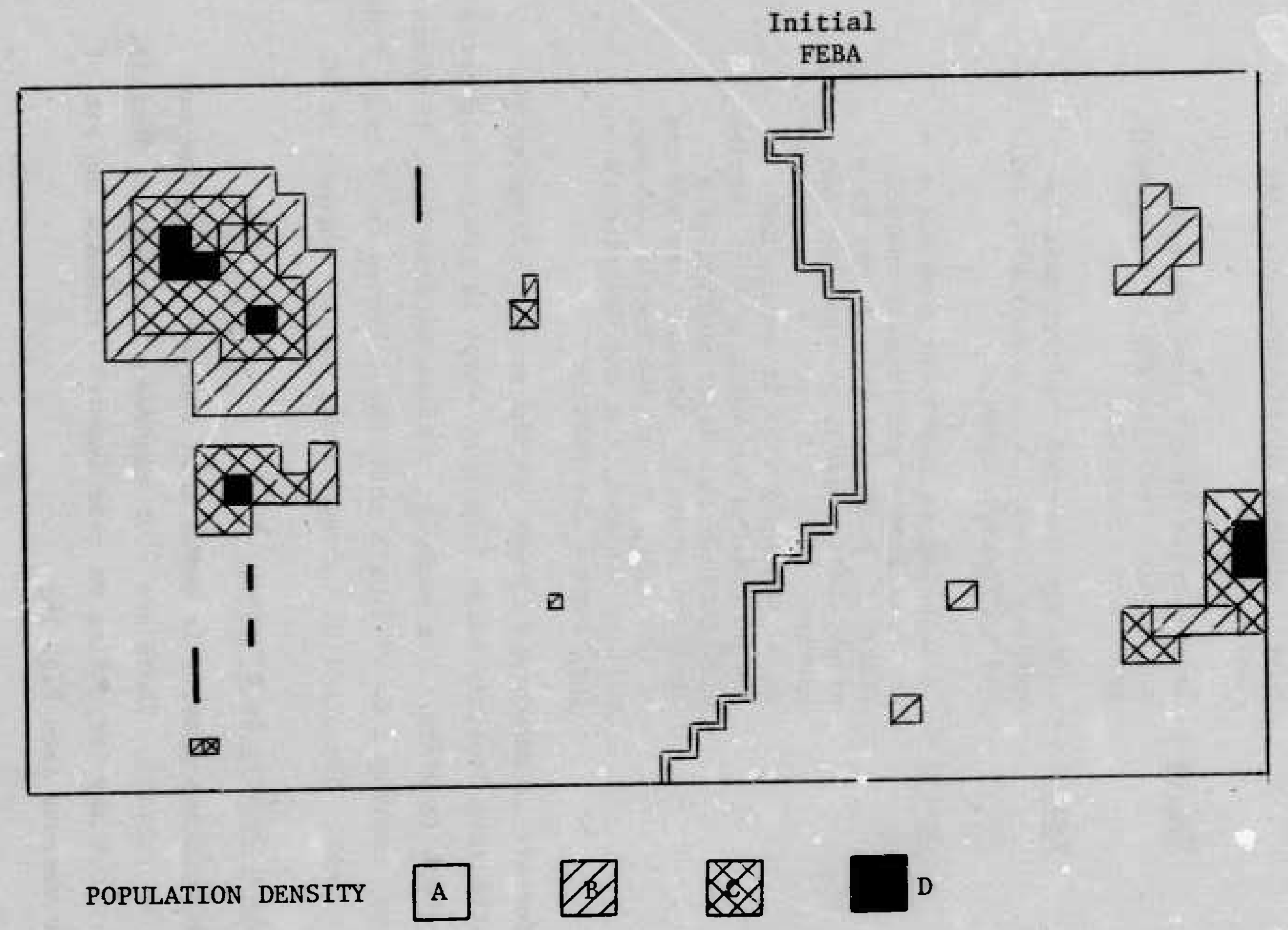

Fig. 19—Population Schematic

Terrain Description

The terrain is divided into four types, all of which have some influence on the mobility of the ground combat units.

<u>Type A</u> - This terrain is flat-to-gently rolling with a minimum of timber—excellent tank country.

<u>Type B</u> - This terrain is marginal for tanks and wheeled vehicles due to topography, soil, and vegetation.

<u>Type C</u> - Tanks and wheeled vehicles must remain on roads due to topography, soil, and vegetation density.

<u>Type D</u> - Is intended to represent some major obstacle that would require special effort to pass through. It may be a river, lake, marsh, or some man-made barrier. Type D terrain is considered to be one kilometer in depth, and the successful crossing of this barrier will consume the major portion of a decision cycle (__ hours). Any advance of the FEBA, due to the battle outcome, will be stopped, for one decision cycle, <u>just</u> beyond the barrier.

Terrain is resolved in depth to the nearest kilometer and laterally into "terrain bands," each of which is given a number of minisectors in width. For example, a given terrain band, 10 minisectors wide, may contain 5 km of Type B terrain, followed by 18 km of Type A terrain, etc. The limit of terrain bands for the theater is 50.

Population Density Description

Population density is coded into the model using the same scheme as terrain. There are four classes of population density, all of which may (depending on user inputs) influence the use of nuclear weapons (see Fig. 19).

Type A - Less than ___ population per hectare—
farm land, forests, etc.

Type B - This is the smallest village or town which can be identified—less than ___ population, but more than ____ per hectare.

Type C - This is the medium-to-medium large city—has industrial base and includes bridges, civilian airfields—less than ____ population, but more than ____ per hectare.

Type D - This is the very large city or area in which the detonation of a nuclear weapon would have grave military and/or international implications.

INITIAL FORCE DESCRIPTION

As each unit in the ground combat model consists of one or more divisions, the user must therefore first define the composition of each division by type.

Division Description:

a. Division type 1-n*

b. Full TOE C^3 Index

c. Full TOE firepower, by mission, delay, defend, attack, rupture

d. Supply consumption rates, by mission, delay, defend, attack, rupture

e. Authorized quantity of personnel, by type

f. Authorized tons of supplies

g. authorized quantity of nuclear delivery systems, by type.

Once each division type is defined, as to type and composition, the total initial ground force may be defined by the following:

* The division type/identifier/nationality code may be used by the target acquisition, assessment and unit reinforcing models should the user wish to constrain/modify the logic of these models by unit type.

Theater:

a. Count of subordinate army groups/fronts

b. Count of aircraft (by type), air bases (by type), SAMs/ADAs, and initial mission allocation

c. Count of nondivisional artillery bns, by type (allocation to subordinate units is accomplished by the MMS logic)

d. C^3 Index

e. Mission

f. Authorized quantity of nuclear weapons by type and yield

g. Frontage coordinates.

Army Group/Front:

a. Count of subordinate corps (NATO), armies (Pact), by type

b. Frontage coordinates (may not exceed those of theater)

c. Initial location, 1st or 2d echelon

d. Quantity of separate arty

e. C^3 Index

f. Authorized quantity of nuclear delivery systems, by type

g. Count of divisions not assigned to Corps,* by type

h. Corps, Army type (1-n)**

i. Authorized quantity of nuclear weapons by type and yield

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* Blue only.

** Should the user wish to control the allocation of resupply, reinforcing units, nuclear targeting, as a function of nationality of the unit; this unit type can serve to associate said unit(s) and higher headquarters, i.e., an example might be:

01-09	all US Corps
10-50	all US Divisions
51-59	all French Corps
60-80	all French Divisions
81-89	all German Corps
etc.	

NATO Corps/Pact Armies:*

a. Count of subordinate divisions, by type

b. Frontage coordinates (may not exceed those of parent HQ)

c. Initial status, 1st or 2d echelon

d. C^3 Index

e. Authorized quantity of nuclear delivery systems, by type

f. Corps/Army type (1-n)

g. Authorized quantity of nuclear weapons by type and yield.

Divisions** (Blue Only):

a. Frontage coordinates (may not exceed those of parent Corps HQ)

b. Initial status, active or reserve

c. C^3 Index

d. Authorized quantity of nuclear delivery systems, by type

e. Division type (1-n)***

f. Authorized quantity of nuclear weapons by type and yield.

Thus at any time during a MINTSIM battle, the unit status file contains the record of the units' strength in terms of men, materials, and supplies; from the status file, the current firepower capability of the unit for the units' current posture (firepower augmentation is by artillery and close air support) can be computed.

---

* A status file with authorized and actual levels is kept for each Red army.

** A status file with authorized and actual levels is kept for each Blue division.

*** See division type description.

The application of expected combat effectiveness may be modified (constrained) due to shortages in supplies and/or personnel (by type).

Referring to Fig. 20, the user must input to the model two (2) numbers (P and Q) which express:

1. (Q), the percent of personnel (supply on hand) below which the unit (division type) will have its combat effectiveness reduced.
2. (P), the minimum percent of combat effectiveness, by division type, to which a unit may fall given either zero (0) or some other minimum quantity of personnel or supplies on-hand.

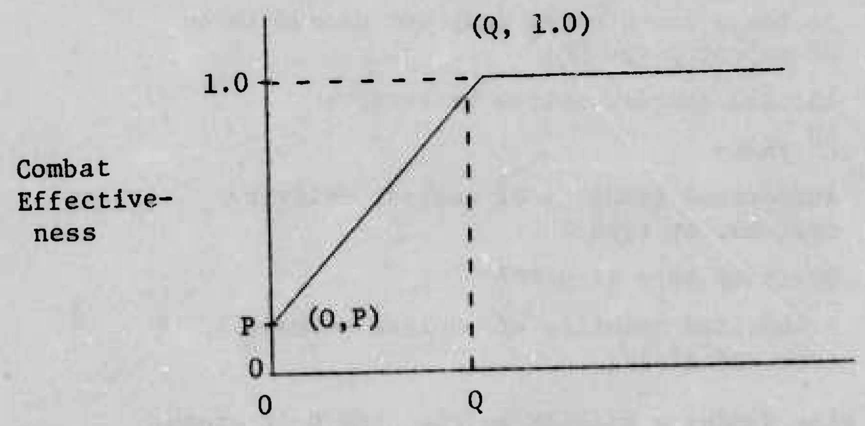


Fig. 20—Percent of Required Supplies On Hand

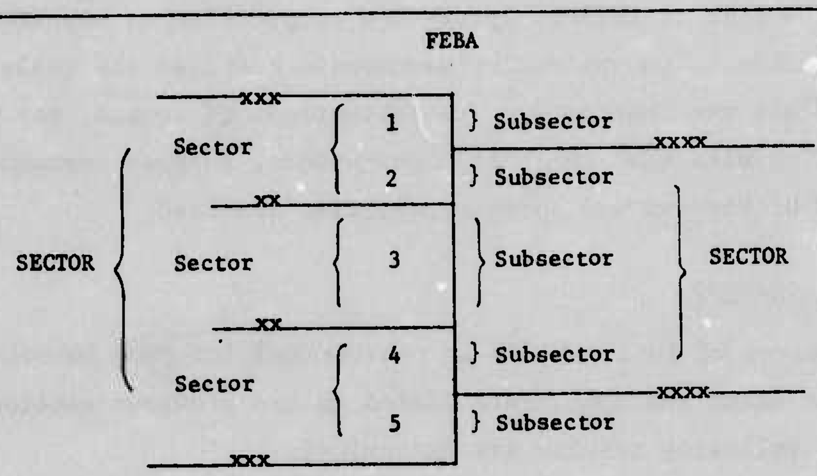
Each division type and artillery battalion type will require the input of a P and Q for: (1) supply, and (2) personnel shortages. This will give the user the flexibility of simulating differing constraints to combat effectiveness as a function of differing shortages to differing division (artillery battalion) types.

In the case where a unit has shortages of both personnel and supplies, the shortage producing the largest constraint on combat effectiveness will be used.

Engagements

After the Red armies and Blue divisions have been assigned sectors, missions, forces, and fire support, the ground battle assessment takes place. An engagement situation is described as follows:

a. Each assessment of a ground battle is based on what is called a "subsector," as shown below.



There are five subsectors.
The left-hand force has one corps and 3 division sectors.
The right-hand force has one army sector and portions of two other army sectors.

b. The strength of the opponents as displayed in unit status files.

c. The artillery support, both organic and non-organic, assigned by a headquarters.

d. Close air support (CAS) sorties assigned by a headquarters.

e. The engagement type (mission of opposing units).

f. The type of terrain over which the battle is to be fought.

g. The C^3 index of the opposing units.

h. Shortages of supplies.

ASSESSMENT

There are two types of assessment in the MINTSIM model: battle assessment and estimation. The battle assessment alters the unit status file to reflect losses and consumption of supplies and moves the FEBA. The estimation assessment computes the goals of combat (E's); see Chapter 4. The estimation, of course, may produce different results than the battle assessment, because commander's estimates of his own and enemy capablities are used.

Battle Assessment

An array of force ratios is constructed for each subsector engagement using the components listed in the previous section, from which the following results are determined:

a. The number of casualties by personnel type

b. The reduction of unit effectiveness as a function of personnel losses and supply state

c. The direction and distance that the local ("subsector") FEBA moves (table look-up)

d. The consumption of supplies during the engagement

e. The reduction in C^3 capability as a result of C^3 personnel losses

f. The abandonment of supplies as a function of FEBA movement

g. Triggers to nuclear options

h. Setting of air model "panic mode" as a function of penetration/rupture by enemy

i. Effectiveness of units represented (history array to be used in estimating enemy next cycle)

j. Unit state (actual on-hand/authorized level).

MINTSIM also has a special assessment procedure to handle penetrations and envelopments.

Penetration

The simulation of the penetration of a defender's principal forward defense area is based on two assumptions:

a. The defensive area is "x" kilometers in depth.

b. The attacker must penetrate the entire depth of the defender's defensive area in one (1) assessment cycle.*

The MINTSIM model provides further tests for the apparently successful penetration, should the indication (force ratio) be that the attacker has penetrated the defensive area. The model now examines whether the attacker can hold and widen the penetration. The attacker must defend the flanks of the penetration by "dropping off" a number of units (quantity of firepower) per kilometer of penetration.

The defending forces use a user-specified defensive doctrine to attempt to contain and "pinch off" the penetration. This defensive doctrine includes:

a. Depth of forward defensive area.

b. Time delay to commit defensive reserve units to penetrated subsector.

---

* E_1 in the MMS calculation is the percent of this defensive area controlled by the defender at the end of the assessment cycle, e.g., a defender, $E_1 = 0$, shows the attacker has completely penetrated the defensive area.

c. Can any portion of defender's neighboring units temporarily divert some percent of their firepower and direct it against the attacker (penetrator) and maintain an "Emergency Defense Force Ratio?"

Should the aggregate firepower of all defenders (counterattacking reserves and neighboring units) exceed the aggregate penetrating attacker's flank protection firepower, the penetration is not successful and rupture has not occurred. The FEBA is advanced (against the defender) to one-fourth the defensive depth. The penetrating unit is cut off and becomes ineffective until reconstituted, although a fraction of its personnel rejoin their parent unit as replacements.

Should the aggregate firepower of the defender (as explained above) not exceed the penetrating attacker's firepower, the penetration is successful and rupture has occurred. The penetration expands to the doctrinal ZOA desired or the ZOA of the major penetrating unit, whichever is less.

The FEBA, in the ruptured subsector, is set to the computed (force ratio table look-up) value (maximum of which may be the defender's defensive depth or beyond). The defending unit which was ruptured will lose a given (user-defined) percentage of personnel, tons of supplies—due to enemy firepower, abandonment, and hasty breakdown in C^3. The ruptured defensive unit will continue to occupy the sector at the "nose" of the attacking enemy, but at a greatly reduced state. It is up to the next cycle estimation process to see if reserve units can:

a. Counter/stop advancing enemy units.

b. Accurately recognize the situation and deliver (by user policy) "panic" mode indirect fire support from CAS and non-divisional artillery.

c. Correct situation by nuclear weapons (user policy).

A successful rupture may be <u>decisive</u>. If the defender cannot contain or reduce the rupture in the next assessment cycle, it is ruled to be decisive. Because MINTSIM is, at present, unable to represent strategic changes of direction by the breakthrough forces, the model assumes the successful, uncontainable breakthrough forces will exploit and overpower the entire defense. Hence the determination of decisiveness in the next assessment period is crucial to MINTSIM continuing to simulate the campaign.

A successful rupture will be nondecisive if:

a. Defender can contain penetrator by establishing a force ratio which permits continued <u>defense</u>

(or)

b. Defender can "pinch off" the successful penetration. [As on pp. 145, 146.]

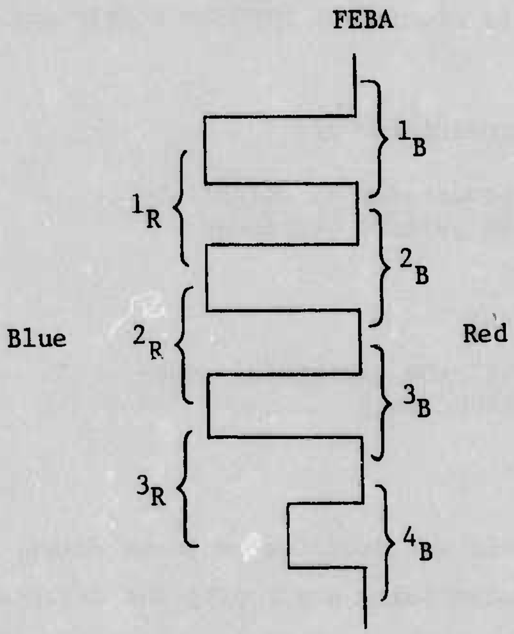
<u>Envelopment</u>

Should two or more successful but not decisive ruptures exist, there is a strong possibility of successfully enveloping the defender's flanked force. MINTSIM assesses potential envelopment before any other ground combat engagements by comparing the depth, D, of the shallower of two neighboring penetrations to the lateral distance, d, separating these two penetrations.

The test is whether D (depth of shallower penetrator's flank) is $\geq$ kd, where k is a constant expressing the user's input as to degree of difficulty/ease to envelop enemy force(s). If D $\geq$ kd, envelopment occurs; the unit(s) in the interval d are encircled, and their effectiveness becomes "x" (user defined) for conventional ground combat assessment. The user must define the percent of the unit escaping prior to and after encirclement, and thus constituting the defending force now occupying this area d of the FEBA. The FEBA will move to D (depth of the shallower penetration) for the entire

area D. The user should keep in mind that this, too, will be used in the E_1 computations and therefore may produce the air model "panic" mode.

For the question "who envelops whom," consider the following rather extreme example which shows the FEBA; and for illustrative purposes, assume each depicted penetration is part of a potential envelopment.

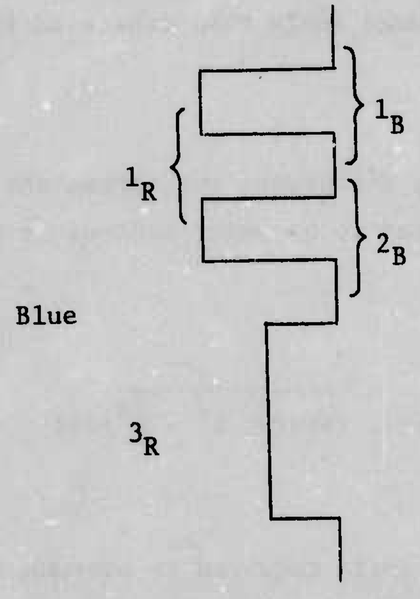


NOTE: Only units whose mission is attack or rupture can be considered as potentially enveloping the enemy. The rather extreme example to the left assumes all units on both sides are attacking.

The ground battle assessment submodel will first scan the entire theater for potential envelopments and find, by side, the two envelopments with the largest force differential.

For example, using the above sample FEBA, Blue 3B, Red 3R, the assessment submodel now compares the force differentials and, should $3_R \geq 3_B$, the Red side envelopment will take place producing the following FEBA (obviously, if 3B > 3R, the Blue side envelopment takes place).

Who Envelops Whom



The assessment submodel now rescans the entire theater for potential envelopments and repeats the previously described steps until no more potential envelopments can be found.

Such multienvelopments as just described are highly unlikely. In lieu of the above procedure which may require considerable running time, the user may wish to have the model stop and enter a manual solution, or have the model assess envelopment on a first-come first-served basis (keeping in mind that assessment is from minisector 1 - N).

ESTIMATION

The assessment process for estimating the goals of combat must be simpler than the actual battle assessment because thousands of estimation assessments, but only one battle assessment, will be made in each period.

In estimating E_1 (control of defensive zone) and E_2 (control of area forward of a critical line), each subsector within the estimator's boundaries must be examined. For each course of action examined, E_1 and

E_2 are the "worst" (for the defender) or "best" (for the attacker) subsector. The remaining goals, E_3 (conserve own capability), E_4 (degrade enemy capability), and E_5 (minimize collateral damage) are determined from the total of all units immediately subordinate to the estimator.

COMPUTATIONS OF E's

E_1, as previously stated, represents the percentage of the defender's defensive zone (depth) estimated to be under control at the end of the period (cycle).

The equation

$$E_1 = \min[1.0, \max(0, \sqrt{\max(0, a^2 - b^2)}/a]$$

where

a is the force ratio required to overrun the defensive area. This is a user input which may be by unit type or area of the battlefield.

b is the estimated* force ratio.

E_2, as previously stated, represents the percentage of the defender's area, forward of a user-defined line, under the estimator's control at the end of the period (cycle).

The equation

$$E_2 = \frac{[D2 - D1(1.0 - E_1) - OVRN]}{D2}$$

D2 is the distance from the FEBA to the user-defined critical line.

D1 is the depth of the defensive area (as in E_1).

---

* The ratio of attacker-to-defender's perceived effectiveness yields the estimated force ratio for the current cycle. See Chapter 7 on the derivation of "perceived effectiveness."

OVRN is given by the equation

$$OVRN = \max[0, D3(b - a)/(EFR - a)]$$

where

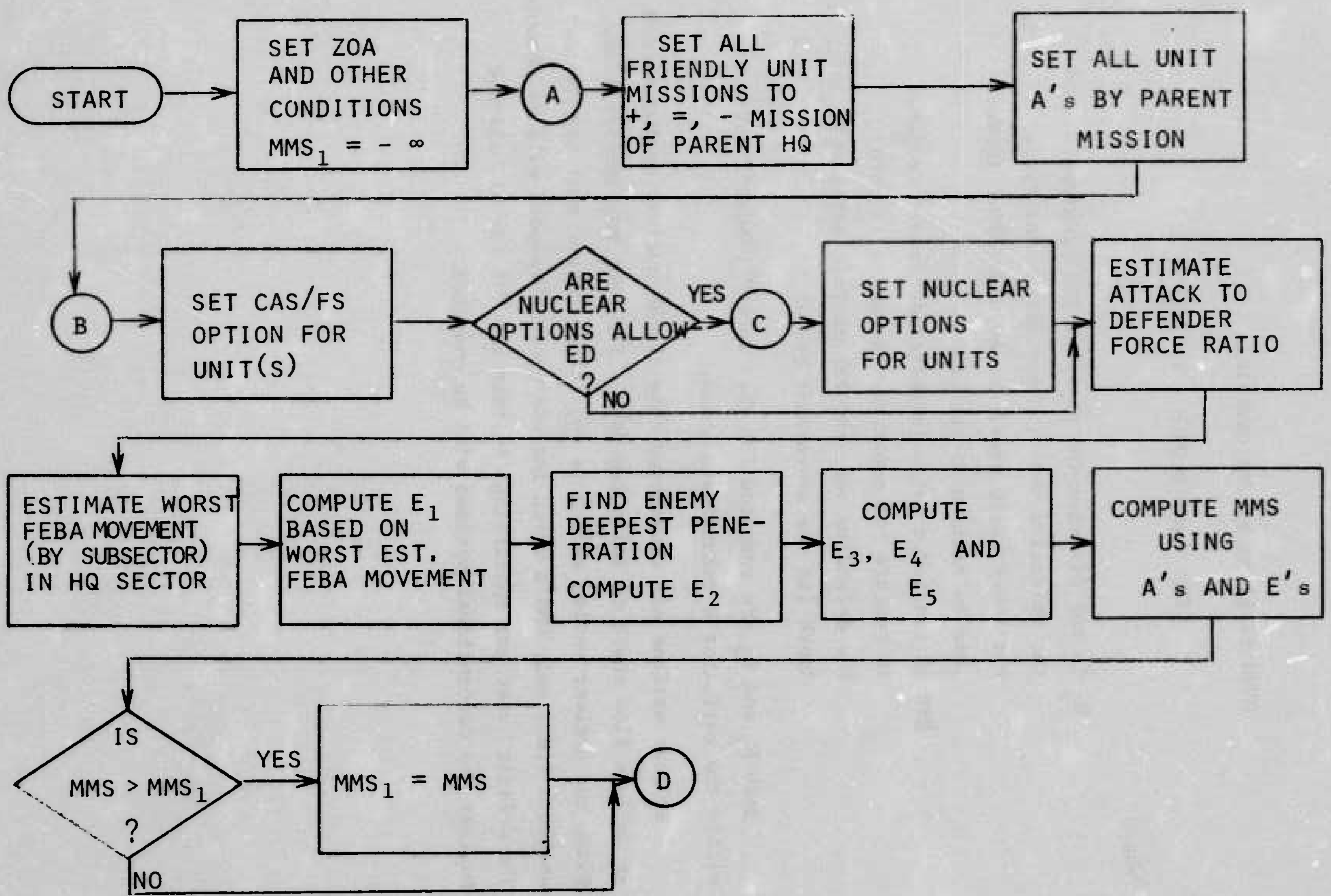
D_3 is the distance the attacker can progress beyond the defensive zone (in one assessment cycle) if his force ratio equals or exceeds EFR. (Note: this is maximum distance.)

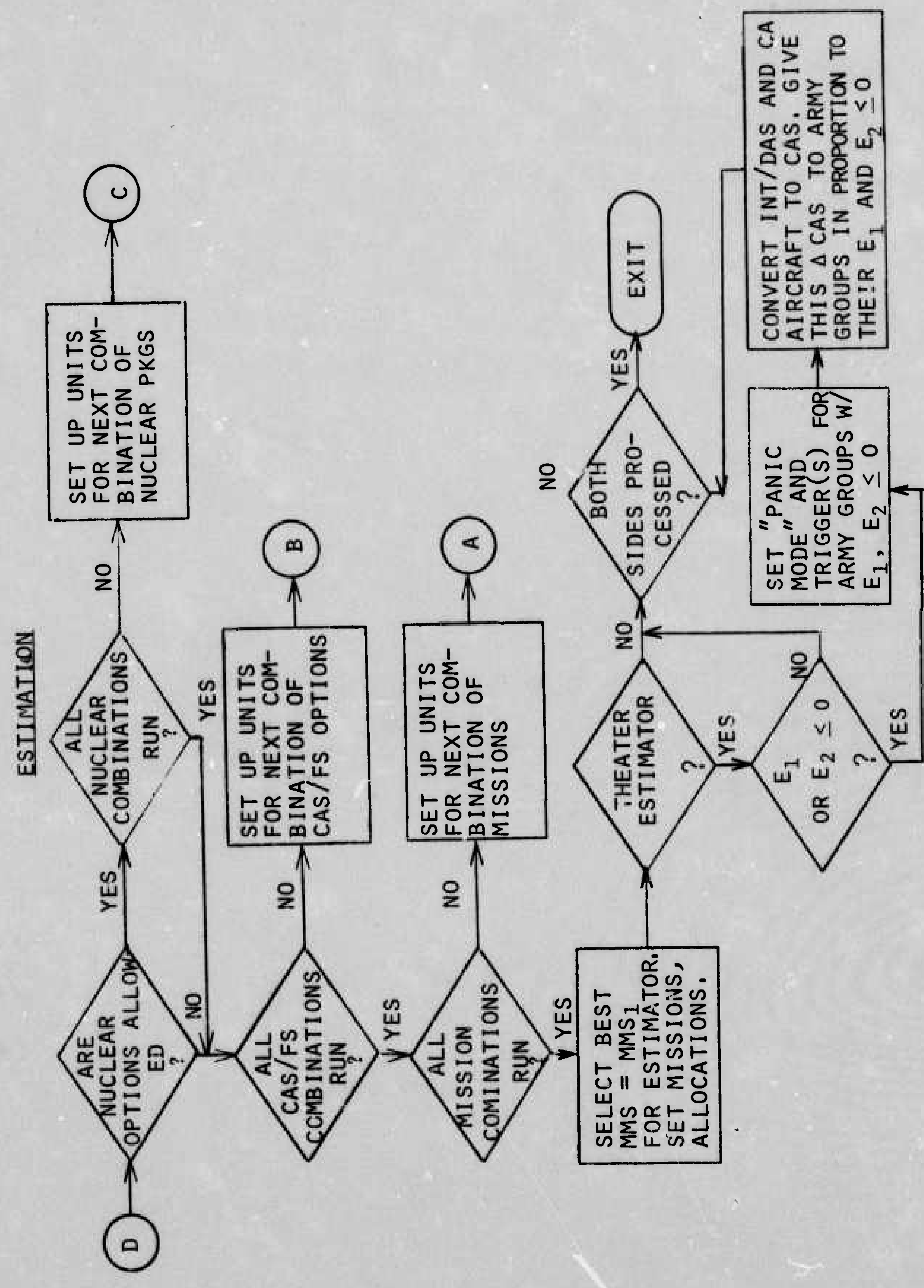
EFR is the force ratio (attacker/defender) required to rupture and penetrate the depth of both the defensive zone and the maximum achievable depth (in one assessment cycle) D3.

Both E_1 and E_2 are computed for the "worst" ("best") subsector within the estimator's subordinate units.

Nuclear options are considered only if the nuclear option switch is <u>on</u> (see flow chart on following page. The user may specify that, given the nuclear option switch is <u>on</u>, the estimator must use nuclear weapons, i.e., only MMS's which include nuclear weapons will be computed. The default (user not specifying) is that the MMS for all allowed nuclear and conventional options will be computed.

ESTIMATION


START
SET ZOA AND OTHER CONDITIONS $MMS_1 = -\infty$
A
SET ALL FRIENDLY UNIT MISSIONS TO +, =, - MISSION OF PARENT HQ
SET ALL UNIT A's BY PARENT MISSION
B
SET CAS/FS OPTION FOR UNIT(S)
ARE NUCLEAR OPTIONS ALLOWED ?
YES
NO
C
SET NUCLEAR OPTIONS FOR UNITS
ESTIMATE ATTACK TO DEFENDER FORCE RATIO
ESTIMATE WORST FEBA MOVEMENT (BY SUBSECTOR) IN HQ SECTOR
COMPUTE E_1 BASED ON WORST EST. FEBA MOVEMENT
FIND ENEMY DEEPEST PENETRATION COMPUTE E_2
COMPUTE E_3, E_4 AND E_5
COMPUTE MMS USING A's AND E's
IS $MMS > MMS_1$?
YES
NO
$MMS_1 = MMS$
D


ESTIMATION
D
ARE NUCLEAR OPTIONS ALLOWED ?
YES
NO
ALL NUCLEAR COMBINATIONS RUN ?
NO
YES
SET UP UNITS FOR NEXT COMBINATION OF NUCLEAR PKGS
C
ALL CAS/FS COMBINATIONS RUN ?
NO
YES
SET UP UNITS FOR NEXT COMBINATION OF CAS/FS OPTIONS
B
ALL MISSION COMINATIONS RUN ?
NO
YES
SET UP UNITS FOR NEXT COMBINATION OF MISSIONS
A
SELECT BEST MMS = MMS1 FOR ESTIMATOR. SET MISSIONS, ALLOCATIONS.
THEATER ESTIMATOR ?
NO
YES
E1 OR E2 ≤ 0 ?
NO
YES
BOTH SIDES PROCESSED ?
NO
YES
EXIT
SET "PANIC MODE" AND TRIGGER(S) FOR ARMY GROUPS W/ E1, E2 ≤ 0
CONVERT INT/DAS AND CA AIRCRAFT TO CAS. GIVE THIS Δ CAS TO ARMY GROUPS IN PROPORTION TO THEIR E1 AND E2 ≤ 0

Chapter 12

USER INPUTS

INTRODUCTION

The purpose of this chapter is to summarize the input data needed to operate MINTSIM and to suggest initial values for these inputs. The input data are of four types: policies, performance measures, criteria, and the initial situation.

Policies

The user may not always find in US or Soviet military doctrine, current policy, or approved studies, detailed statements of the policies required to operate MINTSIM. He must be prepared, therefore, to derive detailed policies from the general guidelines given by higher authority. Since MINTSIM is an experimental tool, one of whose purposes is to examine the effects of existing or alternative policies, the user should have the option of putting in alternative policies.

Performance Measures

In an aggregated model, performance measures are always subject to criticism because it is difficult to validate (from history or test) the military performance of large units: divisions, armies, air forces. It is impossible, of course, to validate the performance of any unit in a conventional-nuclear conflict because no such conflict has ever occurred. There is a natural tendency to neglect factors that are difficult to measure and design models of warfare that can operate with the fewest possible "magic numbers," i.e., numbers that may be impossible, not merely difficult, to validate. On the other hand, neglecting these

factors makes the automatic assumption that they are unimportant, which itself will sometimes be a distortion of reality.

The "softest" or most "magic" of the input performance measures required to operate MINTSIM is the C^3 index. It is not inherently "softer" than many other performance measures, but it is currently "softer" because no existing model has ever had a need for such data. On the other hand, neglect of C^3 makes the automatic assumption that C^3 effects are constant throughout a campaign and attacking the enemy's C^3 provides no military effect. MINTSIM cannot neglect the impact of C^3 on the decision to employ nuclear weapons as well as its impact on subsequent nuclear and conventional operations.

The user should recognize that the numerical values and function form of the C^3 index provided in this chapter are first approximations. The propagating effects of the C^3 index throughout the MINTSIM structure will undoubtedly make it necessary to adjust MINTSIM to avoid inconsistent and unrealistic effects. Such adjustment has been necessary for the major parameters in every large and complex model of warfare.

An effort has been made to provide flexibility in the use of these "soft" numbers so that the MINTSIM program can be adapted to new information and understanding as they are gained from current and future studies.

Performance measures not unique to the conventional-nuclear battlefield may be found throughout the literature of simulations and war games. They are not further discussed in this chapter. Examples are: measures of conventional firepower, unit movement rates, FEBA movement rates, conventional attrition rates in air-to-air, surface-to-air, and ground combat.

Criteria

There are abundant sources for the technical criteria needed to operate MINTSIM. Data from US and Soviet sources exist for missile reliability, CEP, and damage and casualty radii for nuclear weapons. But no sources are known from which the user can develop nuclear damage and casualty radii for temporary neutralization and delay, since there has been no requirement for such criteria. The values presented in this chapter, therefore, should be considered first approximations pending more detailed study.

Many of the tactical criteria and thresholds used in MINTSIM are common to other simulations, such as CEM. Examples are the effectiveness below which a unit must be withdrawn from battle, the supply levels below which a unit starts to become ineffective, and aircraft attrition thresholds requiring a change in role allocation. Tactical criteria and thresholds unique to MINTSIM cannot in general be developed from the existing literature. The most important of these are force ratios for conventional rupture and criteria for envelopment, nuclear triggers, nuclear risk estimation, and nuclear defeat criteria for divisions. The values provided in this chapter are first approximations; future study will undoubtedly require some modification.

Initial Situation

All simulations of theater warfare require a description of the battlefield. a list of units explicitly represented on both sides (including initial combat effectiveness, supply status, subordination, and mission), a tactical plan for both sides, and a reinforcement and resupply schedule. It is assumed that the user has a data bank from which such information can be derived. This chapter will merely list the units represented and elements to be specified without giving numerical values.

INITIAL FORCES AND SCHEDULES

Theater

- No. of alternate headquarters
- Names of subordinate army groups/fronts
- Names of NATO divisions, separate brigades, regiments in theater reserve
- Names of Pact armies under theater control
- No. artillery battalions by type under theater control
- No. medium-range missiles under theater control
- No. short-range missiles under theater control
- No. nuclear custodial units under theater control
- No. nuclear weapons by type not suballocated
- No. developed forward air bases
- No. developed rear air bases
- No. primitive forward air bases
- No. primitive rear air bases
- No. aircraft by type
- No. SAM/ADA bns not adjacent to air bases
- Initial C^3 index
- Initial mission
- Initial aircraft allocation to roles.

NATO Army Group

- Name
- Number of alternate headquarters
- Names of subordinate corps
- Names of divisions, separate brigades, regiments in army group reserve
- No. artillery battalions by type under army group control
- No. medium-range missile launchers under army group control
- No. short-range missile launchers uncer army group control
- No. nuclear custodial units under army group control
- No. nuclear weapons by type under army group control
- Initial C^3 index
- Initial mission and sector.

Pact Front

- Name
- Nationality
- No. alternate headquarters
- Names of subordinate armies
- No. artillery battalions by type under front control
- No. medium-range missile launchers under front control
- No. short-range missile launchers under front control
- No. nuclear custodial units under front control
- No. nuclear weapons by type under front control
- Initial C^3 index
- Initial mission and sector

NATO Corps

Name
Nationality
No. alternate headquarters
Names of subordinate divisions, separate brigades, regiments
No. artillery battalions by type under corps control
No. medium-range missile launchers under corps control
No. short-range missile launchers under corps control
No. nuclear custodial units under corps control
No. nuclear weapons by type under corps control
Initial C^3 index
Initial mission and sector.

Pact Army

Name
Nationality
No. alternate headquarters
No. subordinate divisions by type
No. artillery battalions by type under army control
No. medium-range missile launchers under army control
No. short-range missile launchers under army control
No. nuclear custodial units under army control
No. nuclear weapons by type under army control
Total personnel strength by type
Initial C^3 index
Initial firepower by mission
Supply consumption rate by mission
Initial mission and sector
Initial supply status

NATO Division, Separate Brigade, Regiment

Name
Nationality
No. alternate headquarters
No. attached artillery battalions
No. nuclear custodial units
No. nuclear weapons by type
Total personnel strength by type
Initial C^3 index
Initial firepower by mission
Supply consumption rate by mission
Initial mission and sector
Initial supply status

Artillery Battalions

Type
Firepower index
No. colocated nuclear weapons by type
No. nuclear targets formed by subordinate elements
Supply consumption rate by mission of supported unit.

Developed Air Bases

Maximum daily sortie rate
No. shelters
Shelter repair rate
No. adjacent SAM/ADA battalions
No. colocated nuclear weapons by type.

Primitive Air Bases

Maximum daily sortie rate
No. adjacent SAM/ADA battalions.

Aircraft

Type
Sortie rate from developed air bases
Tons of supply per sortie from developed air bases
Duration of sortie from developed air bases
Sortie rate from primitive air bases
Tons of supply per sortie from primitive air bases
Duration of sortie from primitive air bases.

Arrival Schedule

The day (decision cycle) that forces, not present in the theater on D-Day, are available for commitment is a user input.

Pact armies
NATO divisions, separate brigades, regiments
Artillery battalions by type
Medium-range missile launchers
Short-range missile launchers
Nuclear custodial units
Nuclear weapons by type
Aircraft by type
SAM/ADA battalions

Supply and Replacement Schedules

The user also inputs schedules for continuous resupply and replacement.

Tons per day of all classes of supply
C^3 personnel
Infantry and armor personnel
Artillery personnel
All other personnel.

CHOOSING A COURSE OF ACTION

The critical inputs for choosing a course of action are the goals of combat and the weights assigned to these goals for different tactical missions.

Goals of Combat

In Chapter 4, five goals of combat were suggested. Three of these require direct user inputs.

Control of the Depth of the Defensive Zone (E_1). E_1, for an attacker, is the ratio of the greatest advance in any of his subsectors to the depth of a defender's position. E_1, for a defender, is the complement of the attacker's E_1. If a defender's E_1 is negative or zero, a successful rupture has occurred. A reasonable first estimate for the depth of the defensive position of a division is 15 km for both sides.

Control of the Area Forward of a Critical Line (E_2). E_2 is similar to E_1, except that the numerator refers to the cumulative FEBA movement since the beginning of the campaign, and the denominator refers to the total distance from the initial FEBA to a critical line, which, it penetrated, terminates the simulation. The Rhine-Ijssel line is suggested as an adequate representation of NATO's final defensive line and the Pact's initial theater objective. If a NATO offensive is to be examined, the Oder-Neisse line is a suitable counterpart.

Minimize Collateral Damage (E_5). In Chapter 9, four measures of the maximum tolerable civilian casualties were suggested in order not to restrict MINTSIM unduly. Four values are needed for each: two for NATO and two for Pact, against friendly and enemy civilians. Since the military effect of differing collateral damage policies may be one of the subjects for investigation by MINTSIM, the values suggested below should be considered preliminary.

	NATO Weapons		Pact Weapons	
	on NATO Territory	on Pact Territory	on Pact Territory	on NATO Territory
Absolute number in a given decision cycle	200,000	200,000	200,000	500,000
Percent of population	5%	10%	5%	15%
Civilian/military ratio	1.0	2.0	2.0	5.0
Friendly/enemy ratio	0.5	1.0	1.0	2.0

Weights (A's)

The weights assigned to the various E's for each mission (rupture, attack, defend, delay) will undoubtedly require some adjustment when the MINTSIM model is programmed. The following values are suggested for initial use:

Table 10

WEIGHTING FACTORS, A's, FOR GOALS IN COMBAT

Mission / Goal	Conventional Only				Nuclear & Conventional			
	Delay	Defend	Attack	Rupture	Delay	Defend	Attack	Rupture
Cont Def Zone	.10	.45	.30	.55	.10	.40	.30	.50
Cont Area Fwd Crit Ln	.25	.10	.35	.25	.15	.10	.30	.25
Conserve Own Cpbl	.50	.15	.15	.10	.45	.15	.15	.05
Degrade Enemy Cpbl	.15	.30	.20	.10	.15	.20	.15	.10
Minimize Coll Dmg	0	0	0	0	.15	.15	.10	.10

The absence of detailed studies of conventional collateral damage suggests that no weight be initially given to it.

ADAPTIVE MEASURES

The theater commander assesses the nuclear risk in each decision cycle. When the risk is high, he orders adaptive measures to be taken. The following adaptive measures are suggested:

	High	Low
Disperse aircraft to primitive air bases	x	
Disperse logistic units and facilities	x	
Withdraw nuclear-capable aircraft		x
Withhold dual-capable aircraft		x
Return nuclear-capable aircraft	x	
Conventional attack of enemy nuclear systems	two options	
		x
	x	

One adaptive measure that is not uniformly adopted throughout the theater is the zone of action (sector)* of on-line divisions. The user specifies four zones of action: two for NATO, and two for the Pact. One is a doctrinal minimum; the other represents a higher minimum to increase nuclear survivability. Suggested initial values are:

ZOA (Sector) Width	NATO	Pact
Doctrinal Minimum (km)	10	4
Adaptive Minimum (km)	30	15

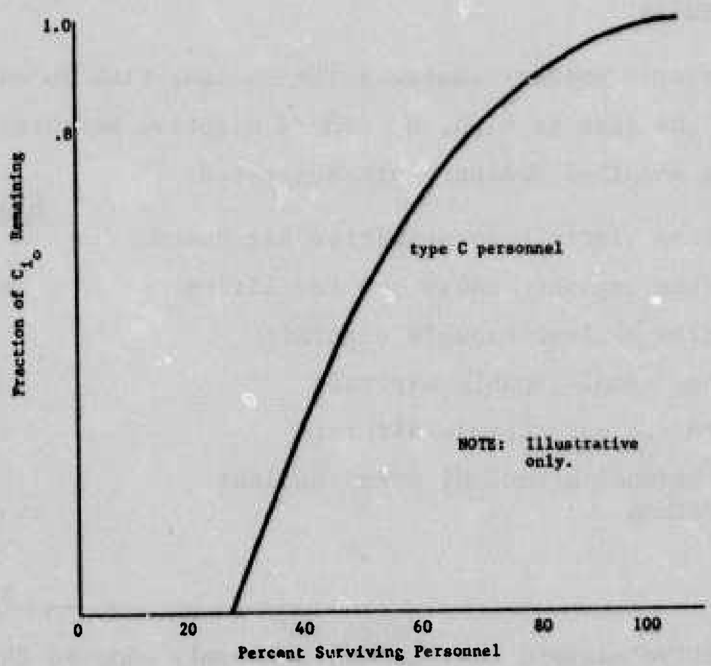
C^3 INDEX

The C^3 index of a unit or headquarters depends on the number of headquarters remaining, the number of C^3 personnel remaining, C^3 equipment, and the occurrence of specified events.

---

* Every ZOA (sector) is an area, not a width. For simplicity, while accommodating slightly varying doctrines, the depth of a ZOA (sector) is taken to be 1.5 times its width.

C^3 Personnel. The impact of C^3 casualties on the C^3 index of a unit is shown below. This represents a very preliminary estimate and may be revised by later studies.



C^3 Equipment. The strength of a unit or headquarters' C^3 stemming from its C^3 equipment is measured by comparing units on the fraction of total investment cost going into C^3 equipment. A more complex measure may be indicated after experimentation, such as comparing unit C^3 equipment on its fulfillment of weighted characteristics such as capacity, security, and mobility.

Headquarters.

$$C = C_o(1 - \frac{N}{N_o})^3$$

where C is the C^3 index after the loss of N of N_o headquarters; and C_o is the C^3 index before headquarters are lost.

Specified Events. The following C^3 index reductions are suggested to account for the temporary impact of specified events. These values, of course, may need adjustment after MINTSIM is programmed.

Table 11

SPECIFIED EVENTS DEGRADING C^3 INDEX

Factor to be Applied to C_i	Trigger	Duration
0.8	1st use of enemy nucs in sector	succeeding period
0.9	1st entry of unit/command on-line	next 2 periods
0.9	viable rupture of own defensive zone	succeeding period
0.9	1st use of own nucs in sector	succeeding period
0.9	adaptive measures	continuous

These values multiply the C^3 index resulting from combat activities during the period.

Functional Form of C^3 Index. Since quantitative studies of the impact of C^3 on the combat effectiveness of units are lacking, there is considerable uncertainty about the functional form of the C^3 index for various applications. The MINTSIM programmer, therefore, should develop the capability for any functional form of C^3 to be applied: linear, concave, convex, or S-shaped. The simplest, fastest, and most general capability is to interpolate among five points provided by the user from the results of future studies.

Until such studies have been made, the following functional forms are suggested for the C^3 index.*

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* Five points from these functions, of course, are easily obtained and can be stored in an appropriate table.

SUMMARY OF C^3 INDEX EFFECTS

Process Affected	Manner of Representing C^3 Effect
CAS and Unit Combat Effectiveness	Effectiveness = FP(unit C_i)$\left(\frac{\text{each HE } C_i}{\text{HE } C_{i_{max}}}\right)$
Reserve Commitment	Reserve effectiveness = normal effectiveness$\cdot\sqrt{C_{i_{\text{HQ Using Res}}}}$
Target Acquisition	Misidentifications increased by factor $\frac{1}{C_i}$ POK multiplied by factor C_i/C_{std}
SAM effectiveness Air operations other than CAS Conv. missile fires	Degraded by $\sqrt{C_i}$ theater
Nuclear weapon effects (NON-PACKAGES)	Elements defeated or targets destroyed multiplied by C_i of commander controlling delivery system.
Replacements, resupply	Amount available reduced by factor $\sqrt{C_i}$. Shrinkage not lost to system; reappears next period.

INTELLIGENCE AND TARGET ACQUISITION

Nuclear Risk

The following table gives suggested values for initial use in assessing the risk that nuclear weapons will be used:

Factor	Value
Own side selects nuclear option	99
Own side took adaptive measures last decision	99
Enemy used nuclear weapons in last 24 hrs.	99
Enemy took adaptive measures in last 24 hrs.	99
Enemy took adaptive measures earlier but did not use nuclear weapons	-20
Enemy used nuclear weapons earlier but not in last 24 hrs.	- 5
Enemy used nuclear weapons earlier but not in last 48+ hrs.	-10
Enemy did not take adaptive measures	-20
Enemy cancelled adaptive measures previously in effect	-30
Enemy winning air battle	-10
Enemy losing air battle	10
Enemy drawing air battle	0
Enemy ruptured own forces	-20
Own side ruptured enemy force	20
Enemy advance but no rupture	-10
Own side advance but no rupture	10
Average FEBA moved less than 1/2 E_1 last period	10
Enemy E_2 value less than 0.5 after 5 days	30
Enemy retreat	5

Intelligence Delay

After D-day, additions to the enemy order of battle will become known to the theater commander with a delay that depends on his C^3 index. The following thresholds are suggested:

No delay	≥ 0.95
1 day delay	≥ 0.8
2 day delay	≥ 0.7
3 day delay	< 0.7

Rear Area Movement and Target Retention Policy

Target acquisition of rear area forces depends on the movement policy of these forces and the length of time targets are retained on the list after the last observation. The following values are suggested for initial use, but these values will almost certainly need adjustment after the model is programmed.

MOVEMENT POLICY

Target Class	Fraction Moved Per Day: Pact Conv.	Pact Nuclear	NATO Conv.	NATO Nuclear
Medium range msls	0.2	0.5	0.3	0.5
Short range msls	0.5	0.75	0.5	1.0
Primitive air bases	0.2	0.5	0	0
Nuclear depots	0	0.75	0.2	1.0
Higher-echelon hqs	0	0.5	0.3	1.0

TARGET RETENTION POLICY

Target Class	Number of Days on List: Pact Conv.	Pact Nuclear	NATO Conv.	NATO Nuclear
Medium range msls	3	4	5	0
Short range msls	2	2	3	1
Primitive air bases	5	2	2	1
Nuclear depots	4	5	5	4
Higher-echelon hqs	5	5	5	5

Modifiers to the POK Table

The authors are unable to offer initial values for the standard number of reconnaissance sorties or the standard C^3 index that represents the overall situation in mind when the POK values were developed. It is suggested that the user and the POK developers work closely together to develop these values and revise or extend the factors as necessary.

Dummy Targets

It is suggested that scarce, high-value units such as SCUD and FROG launchers, nuclear depots, headquarters, and primitive airfields will have a certain fraction that are unrecognized dummies, either physical, electronic, or both. It is recommended that intelligence and other studies be made to develop reasonable values for unrecognized dummies in each important target class. Pending the results of such studies, the following suggested values are offered, but it should be emphasized that these values are not based on any data.

Target Class	Fraction Unrecognized Dummies by NATO	Fraction Unrecognized Dummies by Pact
Medium range missile lnchrs	0.1	0
Short range missile lnchrs	0.05	0
Nuclear depots	0.1	0
Higher echelon hqs	(1 dummy)	0
Primitive air bases	0.05	0

Misidentified Targets

A similar table, based on some experimental data, provides initial values for targets that are misidentified as one of the important classes.

Target Class	Misidentified by NATO	Misidentified by Pact
Medium range missile launchers	0	0
Short range missile launchers	0.05	0.1
Nuclear depots	0.05	0.1
Higher echelon hqs	0	0
Primitive air bases	0.01	0.02

Degree of Knowledge of On-Line Divisions

The subordinate elements of NATO divisions and Pact armies are not explicitly identified in MINTSIM. The effect of nuclear attack against on-line units is, of course, sensitive to the degree of knowledge of these subordinate elements. One factor affecting the degree of knowledge is the C^3 index, discussed elsewhere. The other factors are user inputs. The following values are suggested, recognizing that they may need adjustment after the program has been built.

Time On-Line	Time On-Line Factor (TOLF) Co/Bty Targets	Time On-Line Factor (TOLF) All Other Targets
1 day or less	0.4	0.1
2 days	0.6	0.3
3 days or more	0.8	0.5

Mission	Mission Factor (MSSN)
Rupture, attack, defend	1.0
Delay	0.8
Counterattack against a successful rupture	0.4

	FEBA Movement Factor (FEBF) Attacker	FEBA Movement Factor (FEBF) Defender
$E_1 = 0$ to 0.5	1.0	0.6
$E_1 = 0.5$ to 1.0	0.6	1.0

AIR MODEL

The MINTSIM air model is based on the air model in CEM. Suggested user inputs given here refer only to those inputs unique to MINTSIM.

C^3 index for primitive air base operations	0.8
Panic threshold time, if no rupture	4 days
Shelter construction rate	0
Probability that aircraft on primitive air bases are not seen or take off on warning of impending attack	1/2 probability on developed bases
Probability of intercept of aircraft carrying nuclear weapons	1/2 probability of conv. aircraft

NUCLEAR MODEL

Political Constraints

There are eight defined categories of political constraints on the employment of nuclear weapons. The programmer should provide for at least two more categories to allow for new concepts. Within each category, a number of choices are given, which may be varied by the user. In some categories the choices are mutually exclusive: in others, in any combination. No entry means that no constraint is imposed.

The following values are suggested for initial use:

Constraint	NATO	Pact
Maximum number of weapons to be employed in one decision cycle	10 50 250 unlimited	10 50 250 unlimited
Maximum yield (per weapon)	2 10 60 200 unlimited	20 300 unlimited
Maximum depth beyond FEBA that may be attacked*	on-line divs on-line armies other fwd targets rear targets	on-line divs on-line corps other fwd targets rear targets
Delivery systems excluded	cannon HONEST JOHN LANCE PERSHING aircraft	cannon FROG SCUD A SCUD B aircraft
Targets excluded	air bases msl lnchers nuc depots hqs logistics reserves	air bases msl lnchers nuc depots hqs logistics reserves
Duration of strike (must be less than nuclear cycle time)	1 hr 2 4	1 hr 2 4
National forces that may not be struck	USSR DDR Czech Polish	US FRG UK French Dutch Belgian
National territory that may not be struck	FRG DDR Czech Polish	FRG DDR Dutch Belgian
Other		

* Distances are expressed by types of targets because MINTSIM does not prescribe depths for individual off-line units.

Response Options

The choices above should represent not only initial use options, but the response to enemy use and the opportunity for escalating by steps or by jumps. The following response options are suggested:

1. Ignore enemy use.
2. Constrain MMS nuclear options within initial use constraints.
3. Match perceived enemy constraints (if constraints are not identical, choose lesser rather than greater).
4. Escalate one step in yield or numbers above perceived enemy constraints.
5. Relax delivery or target constraints, if previously imposed.

Nuclear Option Triggers

The following triggers are suggested for the theater commander on each side to consider nuclear options:

Trigger	NATO	Pact
Successful rupture in at least one corps	x	
FEBA less than 20 km from critical line	x	
NATO nuclear sortie capability less than ____ sorties*	x	
Pact E_2 less than 0.5 after 5 days		x
No rupture in 5 days		x
Enemy use of nuclear weapons	x	x
Other		

* Numerical values can be obtained from a number of recent joint and combined war games and studies.

The user must also specify whether the nuclear triggers refer to events that occurred in the battle assessment or to predictions made in the MMS evaluation. For the latter case, the programmer should allow for a different set of constraints.

The user must also specify whether nuclear options are mandatory or optional after a trigger has occurred or been predicted. In the former case, the theater commander may not consider conventional-only options.

Nuclear Attack Policies against On-Line Forces

MINTSIM provides a number of attack policies against enemy on-line forces. These policies may be specified by the user or they may be tied to the mission, capabilities, and situation of the executing commander. The program should allow for both possibilities. One example of a situation dependent set of attack policies is given below.

Policy	Yes	No
Attack maneuver units forward of arty	A	B
Attack artillery batteries	C	D
Attack rear	E	F
Fire on acquired targets only	G	H

Situation A

1. When yields below 5 KT are available AND
   a) conventional attack follows the nuclear strike OR
   b) company/battery degree of knowledge (DOK) is greater than 0.5 OR
   c) planning to pinch-off a viable rupture.

Situation B

1. When situation A criteria are not met.

Situation C

1. When conventional attack follows the nuclear strike OR
2. When company/battery DOK is greater than 0.4 OR
3. Regardless of DOK, if the defeat criteria for at least one-half of batteries can be met with available weapons OR
4. When enemy cannon are present, regardless of DOK if defeat criteria for at least one-third of batteries can be met with available weapons.

Situation D

1. When situation C criteria are not met.

Situation E

1. When DOK of headquarters, nuclear missile launchers, and logistic targets is at least 0.25 OR
2. Regardless of DOK on rear, if sufficient weapons are available within package after fulfilling defeat criteria against maneuver and artillery units.

Situation F

1. When situation E criteria are not met.

Situation G

1. Specified by user for all situations OR
2. When enemy on-line forces have dispersed OR
3. When no conventional follow-up attack is planned.

Situation H

1. When situation G criteria are not met.

It should be emphasized that these policies are purely illustrative; they should not be considered limiting on either the programmer or the user.

Nuclear Damage and Defeat Criteria

Current manuals, studies, and intelligence documents provide the basis for calculating the damage expectancy against rear area targets, such as missile launchers, headquarters, air bases, logistic installations, etc., for each delivery system, weapon type (yield) combination.

Current manuals, studies, and intelligence documents also provide the basis for calculating the effect of nuclear packages against on-line forces when no follow-up conventional attacks are planned.

When a follow-up conventional attack is planned against on-line units, a threshold suggested for neutralization is an initial radiation level equal to the 1965 value for delayed casualties, or 50 percent light damage to the hardest vehicle in the unit.

Division Defeat Criteria

Division defeat criteria are required to develop nuclear packages. Specifications of division defeat criteria, in terms of the percentage of defeated companies, batteries, headquarters, nuclear launchers, and logistic units, may be found in many recent studies.

IMPROVING UNIT STATE

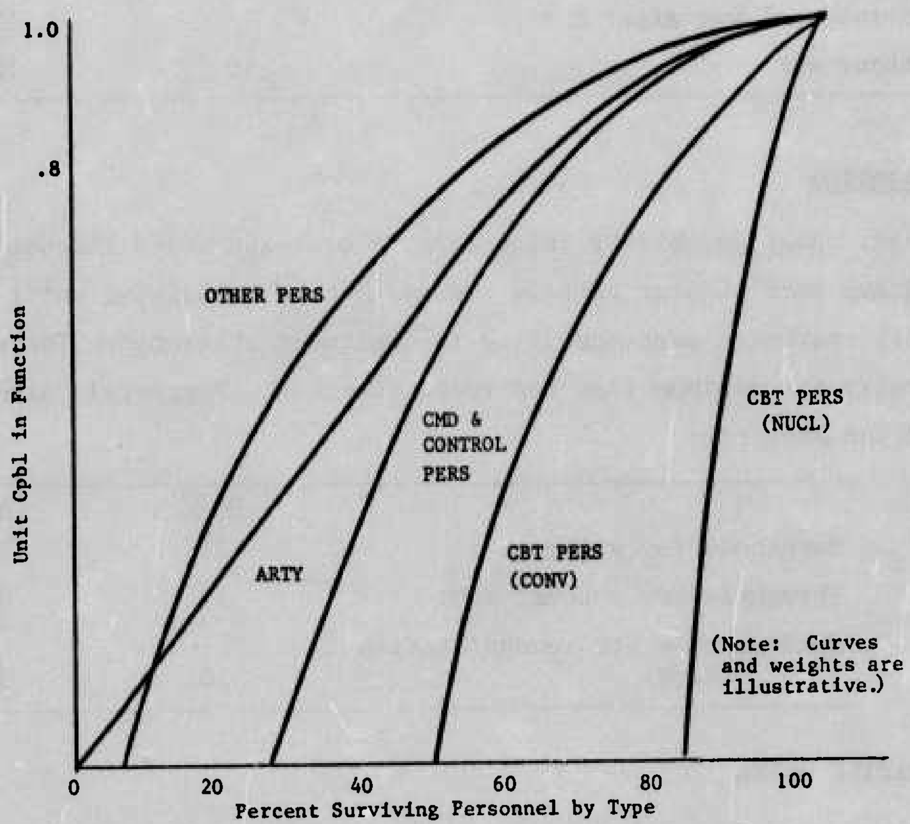
Resupply

MINTSIM treats resupply in much the same manner as CEM, except that all types of supply are combined into a single number of tons,and supplies reaching a unit are reduced to reflect the unit C^3 index and logistic dispersal. The C^3 effects have previously been described. The reduction from dispersal is a user input. It is suggested that the adaptive measure of logistic dispersal be applied to resupply by reducing the C^3 index applied to resupply by 0.1.

Replacement

The replacement system requires normal and critical personnel levels for four types of personnel: combat maneuver, artillery, C^3, and other, for the lowest resolved unit on each side and aggregated for the theater as a whole. Normal and critical personnel levels are derived from user-furnished desired and critical performance levels using some relating function. The model calculates the actual personnel levels after each assessment, compares them with the aggregated normal and critical personnel levels, and allocates replacements in accordance with rules given in Chapter 10.

A suggested initial value for performance as a function of the fraction of each class of personnel on hand is shown below:



Derived input values for the personnel levels are shown, for suggested performance levels:

	Personnel Level			
Performance:	Normal (95%)		Critical (60% NATO; 50% Pact)	
Class of Personnel	NATO	Pact	NATO	Pact
Combat maneuver	93	93	70	61
Artillery	81	81	45	36
C^3	83	83	55	44
Other	76	76	40	26

User inputs are also required to represent the fraction of arriving replacements allocated to units in the theater that are not represented in

MINTSIM. The following input values are suggested:

Situation	Fraction of Replacements for Unrepresented Units NATO	Pact
Conventional war prior to M + 30	40	15
Conventional war after M + 30	15	15
Nuclear war	10	10

Reconstitution

A unit, whose capability falls below a user-specified threshold, must be withdrawn into theater reserve and may not be reassigned until its capability reaches a user-specified recommitment threshold. The user must also specify the minimum time for reconstitution. Suggested values for NATO and the Pact are:

	NATO	Pact
Threshold for withdrawal	25	30
Threshold for recommitment	75	90
Minimum time for reconstitution (days)	10	10

GROUND BATTLE MODEL

The geometry of the battlefield is similar to that of the CEM, so that it need not be repeated here. Forces represented and force status files have been treated earlier in this chapter. FEBA movement and casualties can be assessed in any convenient way, provided they are driven by force ratios (including the C^3 index) and are sensitive to mission of both sides, terrain, adaptive measures, and supply status.

Specifications for rupture and envelopment, however, are new and require user input. The following initial values are suggested:

Force ratio for successful penetration	4.0
Flank protection factor	1 div per 25 km
Emergency defense force ratio	2.6
Lateral distance of defensive forces on each side of penetration available to pinch off	25 km
Flank force ratio to pinch off	Less than 1.0
Fractional losses sustained by ruptured unit(s):	
personnel	0.2 (half rejoin unit next period)
supplies	0.3
C^3	0.5
Personnel loss fraction during envelopment	0.4
Personnel escape fraction (2d period after envelopment)	0.5 (of losses during envelopment)
Residual combat effectiveness	0.2

It must be emphasized that these values will almost certainly require adjustment after sensitivity tests have been run on the completed program.

REFERENCES

1. WSEG Report 275, IDA Tactical Nuclear Warfare (TacNuc) Model, July 1975, UNCLASSIFIED.

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